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Technical Efficiency of the Vietnamese Banking Sector: An Empirical Analysis Encompassing Pre- and Post-WTO Entry

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Technical Efficiency of the Vietnamese Banking Sector: An Empirical Analysis Encompassing Pre- and Post-WTO Entry

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CERTIFICATION

I, **Le Thanh Phuong**, declare that this thesis, submitted in fulfilment of the requirements for the award of Doctor of Philosophy, in the school of Accounting, Economics and Finance, Faculty of Business, University of Wollongong, is wholly my own work unless otherwise referenced or acknowledged. The document has not been submitted for qualifications at any other academic institution.

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ABSTRACT

The nexus between finance and economic growth has been theoretically and empirically examined in the literature. A well-functioning financial system is an essential factor that ensures the sustainable development of economies. Measurements of efficiency and productivity can be used to identify good/bad financial systems. In Vietnam, commercial banks dominate and contribute 90% of the total assets of the financial system (IMF, 2014). Thus, the efficiency and productivity of the banking sector is pivotal to the attainment of economic growth and development in Vietnam. In joining the WTO in 2007 Vietnam had to implement reform measures aimed at further liberalising and increasing the competitiveness of the banking sector. Nonetheless, the existing literature lacks a comprehensive and rigorous analysis of the impact of WTO entry on the performance of Vietnamese banks.

The objective of this research is to conduct an empirical investigation of the performance of the Vietnamese banking sector over the years from 2005 to 2012, encompassing the pre- and post-WTO entry periods. Using measures of efficiency and productivity this thesis sheds light on the following questions: (1) How has the Vietnamese banking sector evolved since its transformation from a one-tier to two-tier system in 1988? (2) Which methods can be utilised to measure and analyse the efficiency and productivity of a banking sector? (3) What has been the level of efficiency and extent of productivity changes in Vietnam's banks encompassing the pre- and post-WTO entry? (4) What has been the impact of policy changes implemented after WTO entry on Vietnam's banks? (5) What are the important sources of inefficiency from the perspective of the Vietnamese banking system?

Data envelopment analysis, a common non-parametric method, is utilised to empirically analyse the technical efficiency and productivity changes of the Vietnamese banking sector. To examine the efficiency difference between periods or bank groups, the Li test and Simar and Zelenyuk (2007) test are utilised. By combining the meta-frontier approach and double-bootstrap two-stage DEA method of Simar and Wilson (2007), the impact of environmental variables on bank efficiency is investigated. A variant of the Malmquist index (so-called aggregate Malmquist productivity index) and Hicks−Moorsteen index (a multiplicatively complete TFP index) is employed to measure and analyse the evolution of the productivity of the Vietnamese banking sector.

Using data for Vietnamese banks covering the post-WTO period (2005-2012), it is found that there is no obvious change of efficiency between the pre- and post-WTO era. State-owned bank groups are the most efficient and have the smallest technology gap relative to that of industry technology. By contrast, and contrary to the mainstream view, joint stock banks are the least efficient group and have the biggest gap relative to the meta-frontier. The impact of reform measures such as transforming rural to urban banks and allowing industrial groups to become involved in the banking sector have contributed negatively to bank performance. There is evidence to suggest that SOCBs privatisation has improved their capability to earn profit but has reduced their efficiency in terms of providing loans. The participation of foreign investors has improved the efficiency of joint stock banks. Regardless of ownership the results illustrate a negative relationship between bank capitalisation and performance as well as a positive impact on profitability. Foreign and joint venture banks are found to be less dependent on lending activities and are more diversified in their operations than domestic banks.

The responses of various bank types can be different to the same explanatory factors. For example, the income efficiency of state-owned banks is positively related with the loan to asset ratio while a negative relationship is recorded in the case of joint stock banks. While financial soundness facilitates the magnitude of lending in the case of foreign and joint venture banks, we observe a negative relationship in the case of domestic banks. The profitability of foreign rivals is independent of intermediation services but a significant dependence is recorded for domestic banks. The analysis of productivity showed that the banking system witnessed a decline during the period 2007–2012 under both the operating and intermediation approach. This issue can be explained by regression of the technical component while the efficiency component was largely unchanged.

This thesis has created a number of contributions to the literature on efficiency and banking. First, this is the first study to take into account the heterogeneity of the business environment when measuring and analysing bank efficiency. Second, by combining the meta-frontier analysis with double-bootstrap two-stage DEA, the author has provided a new approach to analyse the impact of variables on bank efficiency in separate groups operating under different technology sets. Accordingly, ownership is employed as an *ex ante* rather than an *ex post* factor, unlike previous studies, when examining the influence of this environmental variable. Third, outcomes from this study clarify the impact of policy changes' on Vietnamese banking performance in the post WTO era. Fourth, this is the first time that the aggregate Malmquist productivity index that allows accounting for the contribution of individual firms to a whole industry's productivity has been applied in the context of a banking system. Fifth, from the empirical results, a number of policies have been recommended to improve the performance of Vietnamese banking sector from the

perspective of economic integration that Vietnam has been officially a member of ASEAN Economic Community at the end of 2015 and the Trans Pacific Partnership agreement has been signed in December of 2015.

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ABBREVIATIONS

ADB	Asian Development Bank
AMPI	Aggregate Malmquist Productivity Index
ATM	Automated Teller Machine
BFSP	Bank for Social Policy
BIDV	Bank for Investment and Development of Vietnam
BTMU	Bank of Tokyo-Mitsubishi
CAR	Capital adequacy ratio
CC	Credit Cooperative
CIC	Credit Information Centre
DAF	Development Aid Fund
DEA	Data Envelopment Analysis
DFA	Distribution Free Approach
DGP	Data Generating Process
DMU	Decision Making Unit
EAFC	East Asian Financial Crisis
FB	Foreign Bank
FDH	Free Disposal Hull
FDI	Foreign Direct Investment
FJVB	Foreign and Joint-Venture Bank
GFC	Global Financial Crisis
HSBC	Hong Kong and Shanghai Banking Corporation
IAS	International Accounting Standard
IFC	International Finance Corporation
IMF	International Monetary Fund
IPO	Initial Public Offering
JSB	Joint-stock bank
JVB	Joint-Venture Bank
MOF	Ministry of Finance
MTR	Meta Technology Ratio
NAEC	National Assembly Economic Commission

NFSC	National Financial Supervisory Commission
NPL	Non-performing loans
ODA	Official Development Aid
OLS	Ordinary Least Square
SBV	State Bank of Vietnam
SEDP	Social and Economic Development Program
SFA	Stochastic Frontier Analysis
SME	Small- and medium-sized enterprises
SOCB	State-owned commercial bank
SOE	State-owned enterprise
TFA	Thick Frontier Approach
VAS	Vietnam Accounting Standards
VBARD	Vietnam Bank for Agriculture and Rural Development
VCB	Vietnam Commercial Bank
VELP	Vietnam Executive Leadership Program
VND	Vietnam Dong
VRS	Variable Returns to Scale
WB	World Bank
WTO	World Trade Organization

Chapter 1: Introduction

1.1 Background, motivation and objective

It is undeniable that a sound and efficient financial system provides a solid foundation to foster economic growth due to its critical role of providing financial resources in an efficient and effective manner to the rest of the economy (Levine, 2001; Barth *et al*., 2004). This function is implemented via facilitating the trading of risk, allocating capital, monitoring managers, mobilising savings, and easing the trading of goods, services and financial contracts (Levine, 1997). A well-functioning financial sector facilitates a more effective and sustainable usage of an economy's scarce financial resources. However, the quality and functioning of the financial system depends on the financial structure - the mix of financial instruments, markets, institutions and the soundness of the regulatory-supervisory framework.

Over the last two decades, so-called transition economies[1] have been transforming their financial structure from rigid state control to a free market model in which the banking sector has played the predominant role in the financial system. Substantial efforts have been made to build a new financial structure suitable to a market driven economy

[1] According to the Oxford dictionary of economics (the online 4th edition), a transition economy can be understood as "An economy in the process of major changes in its mode of economic organization. This may be from a centrally planned economy to a market-based economy, as in the former Soviet Union and many countries of Eastern Europe [also as in China and Vietnam in East Asia]. It may also be from a policy regime with considerable state intervention to a more liberalized one, as in many developing countries. Transitional economies face special microeconomic difficulties, as they may need to reform their institutions, for example by creating clear property laws and introducing bankruptcy procedures. They also face special macroeconomic problems, as they may need to reform their tax systems, and their monetary authorities may lack relevant experience on which to base their policies. Many transitional economies have experienced slumps in real output and bursts of inflation in the early stages of transition". Downloaded from: *http://www.oxfordreference.com/view/10.1093/acref/9780199696321.001.0001/acref-9780199696321-e-3186?rskey=YihSUx&result=3*

subject to the limitations and legacies arising from the old central-planning regime[2]. The infrastructure of the banking sector has been transformed from a mono-[3] into a two-tiered structure including the central bank and a system of commercial banks totally owned by the state. Financial liberalisation has occurred in all transition economies in order to increase competition and the performance of domestic banks that, consequently, have decreased state-ownership of the sector. The range and speed of liberalisation of banking systems in transition economies has been divergent and can be divided into two categories.

First, full liberalisation which does not impose limits on liberalising measures, such as, for example, regulating the maximal proportion of bank equity possibly owned by foreign investors. Furthermore, governments of transition economies treat banks equally regardless of ownership type and they do not see public banks as a tool to conduct their macroeconomic policies. This type of liberalisation can be observed in the former transition countries in Central and Eastern Europe, where transformation to a competitive and privately-controlled banking sector has been implemented (Bonin and Schnabel, 2011). The second category consists of partial liberalisation in which

[2]The liberalization of former centrally planned economies is logical and essential due to a number of factors including: (1)**inefficient resource distribution**, critics of planned economies argue that planners cannot detect consumer preferences, shortages, and surpluses with sufficient accuracy and therefore cannot efficiently co-ordinate production (Machan, 2002); (2) **suppression of economic democracy and self-management**, planners could never have delivered economic self-management, they would always have been slow to innovate as apathy and frustration took their inevitable toll, and they would always have been susceptible to growing inequities and inefficiencies as the effects of differential economic power grew (see Hahnel, 2015); and (3) **economic instability**, Zielinski (1977) shows that greater fluctuations in output in planned economies compared with market economies is recorded during the same period.

[3] In centrally planned economies, the mono-bank system was responsible for issuing currency, receiving saving deposits, providing payment services among the state-owned enterprises as well as granting financial resources to facilitate the undertaking of various investments, and financing state budget deficits. The collapse of the Communist bloc in the late 1980s and early 1990s triggered a transition of the mono-banking systems in these former centrally planned economies. The first aspect of the transition process was conducted by introducing new central banks with new banking laws, and establishing a two-tier banking system with separate functions for the central bank and commercial banks (Kenjegalieva*et al*., 2009).

liberalising measures are limited and state-owned banks still dominate the banking sector, ensuring the states' control, and consists of countries such as China, Russia and Vietnam. While partial liberalisation, on the one hand, brings private sector opportunities from entering the banking market, it can create a heterogeneous business environment favouring public banks and discriminating against private banks. In the literature the relationship between environmental heterogeneity by ownership type and bank performance has not been examined.

Vietnam has been in the process of transitioning to a fully market oriented economy since the implementation of Doi Moi in 1986. However, the state-owned enterprise sector (SOE), including state-owned commercial banks (SOCBs), still plays a central role in Vietnam's economic development strategies and the Government expects the sector to be a key driver of growth; and to be the material force for the State to orient, regulate and stabilise the macro-economy (Beresford, 2008; Anh *et al.*, 2013). By transforming SOEs in general, and SOCBs in particular, into business groups and eventually sizable corporations, the State has not only favoured them with many resources (especially land, capital, credits, public purchase contracts) but has also created an unfair field of competition, notably a legal framework and policies that discriminate against the private sector, especially domestic private enterprises (Anh *et al*., 2013). This discriminatory policy has resulted in an asymmetric business environment by ownership type between public and private sector enterprises. Hence, Vietnam is an appropriate case study for research on the association between environmental heterogeneity and enterprise performance.

The entry of Vietnam to the WTO in 2007 marked an important point for liberalisation of the country's banking sector; accordingly, a number of policy measures were

conducted to improve bank performance and competitiveness. As part of the country's commitments to the WTO, overseas banks were now allowed to open 100% foreign-invested banks that operated with advanced technology and a high quality of governance. Foreign investors were allowed to take part in domestic banks as minority shareholders. Rural banks were permitted to transform to urban banks under inadequate selective processes (NAEC, 2012; IMF 2014). Four of the five state-owned banks were equitized but the bulk of equity is still held by the State ensuring its continuous control over this important sector.[4] Moreover, foreign strategic investors were encouraged to participate under the expectation that they would bring in their advanced banking technologies as well as expertise.

The pre- and post-WTO entry periods experienced rapid credit growth at an average rate of 35% annually. In an infant financial system with a weak regulatory and supervisory framework such as Vietnam's, the booming credit resulted in high non-performing loans (NPLs) and systemic problems (Pincus 2009; IMF 2014). These above-mentioned policy changes after WTO entry are likely to have significantly impacted bank efficiency; however, no study has been carried out to assess these possible impacts. Therefore, using data for the years 2005–2012, the main aim of this study is to shed light on the impact of WTO entry on bank performance in Vietnam.

This study investigates the performance of the Vietnamese banking system under the impact of WTO entry with the objectives described as below:

[4] After being equitized the shares of these banks are traded in the stock exchange.

First, this study investigates the level of bank efficiency and whether there has been an improvement and convergence of the technical efficiency of the Vietnamese banking sector since accession to the WTO.

Second, this study will identify the key determinants of efficiency change in the banking system in the pre and post-WTO entry periods.

Third, this study will measure and analyse the sources of total factor productivity changes of Vietnam's commercial banks.

Finally, this study will identify effective policy measures that will improve the technical efficiency and productivity of the Vietnamese banking sector.

1.2 Research questions and Hypotheses

The conduct of this study is to answer the following questions:

1) How has the Vietnamese banking sector evolved during its transforming from a one-tier to two-tier system starting in 1988?

2) What methods can be utilised to measure and analyse the efficiency and productivity of a banking sector, especially in the case of a transition economy such as Vietnam's?

3) What has been the level of efficiency and productivity changes in Vietnam's banks encompassing pre- and post-WTO entry?

4) What has been the impact of policy changes implemented after WTO accession?

5) What are the important sources of inefficiency in the Vietnamese banking system?

Hypotheses

The SBV did not consistently supervise the capital participation by business groups into banks, and especially that of SOEs. The chartered capital invested in the JSBs by SOEs increased from 1 trillion dong in 2005 to 15 trillion dong in 2012 (World Bank, 2012). The expansion of industrial group involvement in the financial sector raised questions over the allocative efficiency of credit when these groups have used the banks as a source of financing for their own business activities (intra lending) rather than profitable projects. It is assumed that permitting business groups to take part in the banking sector would decrease banking efficiency. Hence:

Hypothesis 1:

The capital participation of several large SOEs and private business groups decreased the efficiency scores of banks.

The privatisation of SOCBs was a logical and essential step in order to increase their competitiveness and market-orientation in their operation.[5] Lending by the SOCBs is significantly affected by the SBV which still holds the majority ownership of these banks. Furthermore, local governments can influence the allocation of credit due to an administrative relationship between these local authorities and SOCBs' branches in provinces and cities (Oh, 1999; Kovsted *et al*, 2005). These interventions can lead to adverse selections; consequently less profitable, and politically driven, projects are funded while commercially viable projects are abandoned. When their loans became riskier the expected profits of the SOCBs declined sharply as a result of high loan-loss

[5] Via privatisation, public banks can reduce the proportion of shares held by the state, therefore the problem of agency can be diminished (Bonin *et al.*, 2005b).

provisioning (Kovsted *et al*, 2005; WB, 2007). One important solution against this problem is to privatise the SOCBs and list these banks in the domestic stock exchange (WB, 2007). To do so, SOCBs have had to be audited by international independent auditing companies and disclose financial statements to the public and investors. Via privatisation the management model of joint stock corporate has been applied and private investors can take part in the board of directors of these banks. Such changes have resulted in a more transparent and perhaps efficient operation of the SOCBs. In fact, in this way, privatisation can reduce agency problem and therefore increase the private banks' input/output management (Bonin *et al.*, 2005a; b). Thus, the impact of privatisation on SOCBs' performance will be tested in this thesis with below hypotheses:"

Hypothesis 2:

Privatisation of SOCBs has increased the technical efficiency of these banks.

As a requirement of WTO entry Vietnam has had to open its banking market. Foreign investors are now allowed to partly own domestic banks through purchasing banks' shares. Through assigning their staff to the Board of Directors, and Board of Management, foreign banks can positively contribute to the decision making process to improve technology, quality of management, and develop new banking services and products.[6] Moreover, through capital participation foreign banks can refinance domestic

[6] Some may argue that there are three potential impacts of foreign involvement in domestic banks. Firstly, it improves the quality of management (technical efficiency). Second, foreign participation can help improve technologies using in these banks (technical progress). Lastly, more products and banking services originating from foreign investors can be provided to customers (economies of scope). However, only technical efficiency of domestic banks can be considered. Because to make the regression results significant, we need a large size of sample and so the annual data was pooled. Consequently, the movement of production frontiers over time (technical regress/progress) and a variety of efficiency

banks, helping these banks achieve the capital adequacy ratio imposed by the SBV. Consequently, the involvement of foreign investors can be expected to have a positive impact on banking development in Vietnam. In this thesis, the impact of foreign involvement on the quality of management leading to an improvement of technical efficiency of Vietnamese banks will be tested via the following hypothesis:

Hypothesis 3:

Foreign involvement in domestic banks (both SOCBs and JSBs) has exerted a positive impact on the technical efficiency of Vietnamese banks.

The post-WTO duration has witnessed deregulation of banking authority. During 2005−2007, 13 rural banks, which had a narrow scope of operation in rural areas and low-quality management, were permitted to transform into urban banks. As a result, these banks were forced to increase their equity by 10-20 times more than that in 2011 (NAEC, 2012). A dramatic growth in the equity and assets of these banks raised questions about their loans and asset quality. It is assumed that the transformed banks would reduce the efficiency of the banking sector; accordingly the below hypothesis will be considered:

Hypothesis 4:

The deregulation[7] of rural banks into urban banks by the SBV reduced the mean efficiency of the banking sector.

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measures including economies of scope cannot be observed. It is worth noting that only technical efficiency can be measured when annual data is pooled.

[7]Transforming rural to urban banks is a policy measure in order to increase competitiveness and efficiency of Vietnamese banking system and this measure is allowed by the regulators. However, this process is inadequately selective and so the term "deregulation" was used to present this process.

1.3 Methodology and Data

The above mentioned research questions and hypotheses will be addressed utilising an appropriate methodology that can be applied in the context of a transition economy such as Vietnam's.

Hughes and Mester (2008) argue that there are two common approaches to measuring the performance of banks: non-structural and structural. The non-structural approach, based on a variety of financial ratios which capture a specific aspect of performance, compares bank performance based upon different investment strategies adopted and characteristics of governance. For example, the return to assets ratio demonstrates the correlation of profitability and the quality of banks' governance. Despite the fact that a number of formal and informal theories advocate such investigation, no general theory of performance provides a unifying framework for these studies (Das and Ghosh, 2006; Richard *et al*., 2009). The structural approach is grounded on so-called traditional microeconomic theory of the production process and the concept of optimisation (Hughes and Mester, 2008). The advantage of this method relative to the non-structural is that it accounts for the multidimensional character of bank performance which is not the case for the non-structural approach (Berger and Humphrey, 1997). Therefore, the structural approach is the focus of this study and will involve deriving an efficient production frontier for Vietnamese commercial banks during the 2005−2012 period.

A unique aspect of this study is recognition of the heterogeneous nature of the business environment in Vietnam due to discriminatory policies by government favouring state-owned enterprises over those in the private sector, for the economy as a whole and the

banking system in particular. Accordingly, public banks may be in a better position to reach the best-practice performance than their private counterparts. To address this issue a new technical approach will be applied based on the meta-frontier approach of O'Donnell *et al*. (2008), which allows for measuring and analysing firm efficiency in separate groups belonging to different technology sets. This approach can account for the heterogeneity of the economic environment based upon using various group-frontiers.

There are two popular methods to estimate an efficiency frontier in empirical studies: stochastic frontier analysis (SFA) and data envelopment analysis (DEA). The DEA method, however, is preferable in this study because, unlike SFA, it does not make assumptions about the functional form of the relationship between inputs and outputs. Instead, a production set is established from the inputs/output combinations consisting of a piecewise linear boundary identifying the best-practice firms or efficient firms and interior including the inefficient firms. The second reason behind this preference is that DEA is a non-parametric technique; hence, it is more suitable to apply in small-sample-size studies in comparison with SFA, a parametric one, requiring big data sets (Sathye, 2001). DEA models allow multiple-outputs which is a significant advantage when compared to SFA where a single output is regressed against a set of inputs under an *ad hoc* production function. Based on the above comparisons this thesis is more suited to using the DEA method in the context of the Vietnamese banking sector where there are a limited number of banks but a variety of products relating to lending and payments.

Despite these mentioned merits of DEA it is, however, exposed to the limitation that technical efficiency estimated by this method is downward biased and it is impossible to build a confidence interval with a given degree of accuracy. Simar (1992) suggests applying bootstrapping, a statistical technique for making inferences of certain estimates, as a solution to this problem. In this study, several bootstrap-based DEA models are utilised to acquire consistent results of banking performance in Vietnam. To investigate differences in efficiency amongst groups the Simar and Zelenyuk (2007) test, based on the subsampling bootstrap technique and the concept of aggregate efficiency, is used. The Li (1996) test, adapted in the context of efficiency analysis by Simar and Zelenyuk (2006) on the equality of the efficiency distribution, is used to examine the capability of different groups to mimic the efficient production frontier. In addition, the study chooses a truncated regression suggested by Simar and Wilson (2007) (the so-called double-bootstrap two-stage DEA) to examine the influence of environmental variables on bank efficiency as the appropriate method that can overcome the biased nature of DEA estimates in comparison with that of the OLS and Tobit methods.

In terms of productivity analysis a modified and aggregate version of the Malmquist index, based on aggregate technical efficiency, is used to measure and analyse the productivity of banks, accounting for the relative importance of individual banks in the index. The aggregate Malmquist index enables decomposition of the causes of productivity changes into two different sources: efficiency change and technical change. By cross-tabulating the productivity index to types of ownership (public versus private)

the impact of different types of ownership on the performance of Vietnamese banks can be identified.

Data

Panel data is collected from the financial statements of commercial banks in Vietnam, including their balance sheet and income reports. These statements are compiled under Vietnamese Accounting Standards (VAS), which are regarded as being of a lower standard than that of international accounting standards. Being a transition economy, Vietnam experiences data problems that are relevant to all other similar countries (Havrylchyk, 2006). Banks do not compile their financial statements strictly by accounting standards; and non-compliance to the rules set by the supervisory authorities is widespread. Additionally, the other serious problem is unequal treatment between private and public banks, which has deteriorated the transparency of the banking sector.

The period of coverage of the data is from 2005 to 2012. Due to a significant change of regulations on bad loan classification and loan-loss provisioning in 2005, only data from 2005 forwards ensures homogeneity. Furthermore, the studied period should cover the pre- and post-WTO era to observe the impact of policy changes on bank efficiency. Nonetheless, the data is unbalanced due to new bank entries and bank mergers during the post-WTO period.

With a two-digit inflation rate on average covering the period 2005−2012 (about 11-12%), the balance sheet of banks has significantly deteriorated. It is, therefore, appropriate and essential to convert all data into real terms.

1.4 Contribution of the study

This study contributes to the literature of bank efficiency in several unique ways. First, this thesis takes into account the heterogeneity of the business environment when analysing the performance of the banking sector in Vietnam - a transition economy. All previous studies have overlooked the significance of environmental differences when examining the impact of financial liberalisation on bank performance. Hence, this thesis conducts an in-depth analysis on the impact of reform measures on bank efficiency under the assumption that ownership can result in a divergence of technologies utilised by bank groups. Accordingly, the author employs ownership as an *ex ante* rather than an *ex post* factor, unlike previous studies, when observing the influence of this environmental variable. Second, this is the first study to investigate the impact of joining the WTO on a country's banking sector, where the government of that country has to remove restrictions against foreign investors. Third, it is the first study to apply the method of aggregating technical efficiency in a banking system to measure and compare the bank efficiency of different bank sub groups. Fourth, by combining a meta-frontier analysis with double-bootstrap two-stage DEA this study provides a new and unique approach to analyse the asymmetric impact of variables on bank efficiency in separate groups operating under different technologies.

1.5 Organisation of the dissertation

This thesis consists of eight chapters. After this introductory chapter the rest of the study is structured as follows: Chapter 2 overviews the evolution of the Vietnamese banking system from 1988 to the present. An historical approach is adopted in this

chapter due to the fact that historical events and structures have had an enduring effect on recent banking issues. Development of the Vietnamese banking sector is divided into four different phases. In each phase, both positive and negative changes in policies, legislation and institutions which have influenced the performance of banks are reviewed.

Chapter 3 reviews the literature on banking efficiency including methods used in previous studies to measure and analyse bank performance; furthermore, the impact of liberalisation on the banking sector is overviewed under a reversed pyramid model starting with the worldwide context, next to transition economies and lastly to the Vietnamese circumstance.

Chapter 4 presents the methods used to obtain the empirical results from this study. In general, a meta-frontier analysis is demonstrated to be an appropriate approach to analyse the Vietnamese banking sector where the business environment is heterogeneous. Production frontiers at both the industry and group levels are estimated by DEA, a linear programming technique. The methods of Simar and Zelenyuk (2006; 2007) are used to investigate differences in the efficiency of bank groups in this chapter. To investigate the variation of bank efficiency, the double-bootstrap two-stage DEA of Simar and Wilson (2007) is adapted, giving consistent and unbiased coefficients. Productivity change is also measured using a variant of the Malmquist index, grounded in the concept of aggregate efficiency.

Chapter 5 provides a description of the data and presents the technical efficiency results. Specifically, the efficiency of banks between pre- and post-WTO accession is compared using the Li (1996) and Simar and Zelenyuk (2007) tests. These tests are also applied to

investigate differences in efficiency amongst three groups (state-owned, private and foreign banks).

Chapter 6 provides an in depth interpretation and explanation of efficiency variation by employing the double-bootstrap two-stage DEA. In detail, variables consisting of those proxied for policy changes, bank characteristics and time trends are separately investigated. In addition, bank productivity and sources of productivity changes are considered using the aggregate Malmquist index.

Chapter 7, based on the empirical results and findings of the two previous chapters, proposes several policy implications and recommendations to the relevant authority in order to improve the efficiency and productivity of the Vietnamese banking sector.

The last chapter, chapter 8, summarises the major contents of this thesis and highlights its contributions as well as limitations; accordingly, further research is also suggested. It also discusses major findings relating to the research questions posed in Chapter 1.

Chapter 2: Banking Sector of Vietnam 1988−2015

2.1 Introduction

There is evidence to suggest that economic growth is closely and positively related with a country's level of financial development (Levine, 1997; Beck *et al*, 2000a; 2000b; Bonin and Wachtel, 2003; Fethi and Pasiouras, 2010). In particular, economies with larger banks and more dynamic stock markets achieve higher growth rates even after controlling for many other factors underlying economic growth (Levine, 1997).[8] The positive impact of financial development on growth has been recorded in both developing countries and developed countries (Levine, 1997; 1998; Sarazervos, 1998). Through functions such as allocating capital, monitoring managers, mobilising saving and easing the trading of goods/services a well-functioning financial system contributes to efficient resource allocation, which in turn generates higher efficiency and productivity in the production process (Levine, 1998; Sarazervos, 1998).

The banking sector is the traditional component of financial systems in transition or newly emerging market economies, where non-bank financial institutions[9] did not exist before the transition process from centralised to market oriented economies started (Harsan and Marton, 2003). In Vietnam, after the initiation of the transition process began in 1986 under the slogan of "Renovation" -"Doimoi", the banking sector has dominated the financial system (O'Connor, 2000; Kovsted *et al*., 2005; Leung, 2009). Regardless of the development of non-bank financial institutions in recent years, commercial banks maintain a crucial and dominating role in the Vietnamese financial

[8] The size of banks in particular countries was measured by total assets or liabilities relative to GDP. The author used market capitalisation relative to GDP to measure the size of stock markets.
[9] Non-banks include insurance companies, investment banks, finance companies and pension funds.

system. Therefore, this explains the explicit concentration on one type of financial intermediation – the banking sector, in this thesis.

The objective of this chapter is to perform an analysis of the evolution and development of the banking sector over the period 1988−2015. In addition, the performance of the commercial banks will be analysed in depth for the post-WTO entry period (2007−2015).

The remainder of this chapter is structured as follows. A brief history of the banking sector is conducted in Section 2.2. The performance of commercial banks in the post-WTO entry period (2007−2015) will be focused upon in section 2.3. Lastly, a summary of the key issues identified in this chapter will be discussed in section 2.4.

2.2 A Brief History of Vietnam's Banking Sector

A reasonable explanation for the historical approach adopted in this section is that historical events and structures continue to exert large and significant effects on the contemporary problems and issues of the Vietnamese financial sector (Kovsted *et al*, 2005). In line with analyses of external financial crises (the East Asian Financial Crisis triggered in 1997 and the Global Financial Crisis triggered in 2008) as well as internal changes, the historical background of the Vietnamese banking system can be usefully divided into several phases:

1. The first phase was marked by a transition of the banking system from 1988 to 1997. The transition process resulted in the creation of a two-tier banking system that consisted of the State Bank of Vietnam (SBV) playing the role of a central

bank, and a number of commercial banks. This phase ended with the onset of the East Asian Financial Crisis (EAFC) in 1997.

2. The second phase started in 1998 with a substantial change in the legal system. The issuance of the Banking Law strengthened the autonomy and functions of the SBV, and eliminated direct political control over the interest rate. The banking sector was urged to reform not only the State-Owned Commercial Banks (SOCBs) but also the Joint Stock Banks (JSBs). Furthermore, preparation for WTO entry[10] was initiated with a master plan[11] for the banking sector.
3. The third phase witnessed a dramatic growth in the banking sector after joining the WTO in 2007. Large capital inflows from the world market were directed to Vietnam with the prospect of financial liberalisation. However, hidden risks from financial asset bubbles or intra-lending activities have threatened the stability and sustainability of this sector. The Global Financial Crisis (GFC) exposed these risks and brought the banking sector to the brink of a crisis in 2009.
4. The fourth phase started from 2010 up to the present 2015 with a series of measures in order to stabilise the system. These measures consisted of applying restrictive monetary policy, imposing a credit growth rate for each bank, issuing a new capital adequacy ratio, and consistently supervising weak banks. However, the results and efficiency gains arising from these measures remain questionable for both the public and the authorities.

[10] Vietnam was accepted to be a member of the WTO in November 2006 and officially became a WTO member from 1 January 2007.

[11] The master plan included all the changes as part of the agreement for WTO entry through establishing a legal framework. Furthermore, the plan also referred to solutions which aimed to improve the banking sector including SOCBs privatisation, strategic foreign investors, and increasing minimum capital requirements.

2.2.1 Establishing a Market-Oriented Banking System (1988−1997)

In the centrally planned economy of Vietnam (1975−1986)[12] the state had monopoly control over all financial transactions through the SBV, which operated both as a central bank and as a commercial bank (Irvin, 1995). Furthermore, the state controlled two other specified banks, namely the Vietnam Commercial Bank (VCB) a foreign trade bank, and the Bank for Investment and Development of Vietnam (BIDV). The SBV and these two specified banks were responsible for providing credit to SOEs or compensating for budget deficits (Harvie and Hoa, 1997; Beresford and Phong, 2000). The functions of the banking system were restricted, being seen primarily as an instrument of government for executing its economic policies (IMF, 1998).

At its sixth National Congress in December 1986, Vietnam's Communist Party made a decisive step to abandon the centralised economic model and to adopt a socialist market-oriented economy – also known as "DoiMoi" (Renovation) (Harvie and Hoa, 1997; Beresford, 2008). A wide scope of reforms consisted of those relating to State-Owned Enterprises (SOEs), foreign trade liberalisation, tax reform and banking reform (Harvie and Hoa, 1997; Oh, 1999; Beresford and Phong, 2000; Phan *et al*., 2006). In the banking sector the mono-bank system, which only served the needs and demands of the state sector, was split into a two-tier banking system, including the SBV as the central bank and four SOCBs[13].

[12]The North and South of Vietnam were unified in 1975, and in the aftermath the country adopted a centrally planned model of economic development, imitating the Soviet Union.

[13] VCB and BIVD are two SOCBs established during the time of the centrally planned economy. In 1988 the government established two other SOCBs, they are the Vietnamese Bank for Agriculture and Rural Development and the Industrial and Commercial Bank of Vietnam.

From 1990 entry into the banking sector has been liberalised with the participation of private sector and foreign investors (WB, 1993; IMF, 1998). This was one of the most impressive reforms implemented by the government (WB, 1993). At the end of 1992 the structure of the banking sector included the following:

- The four SOCBs (VCB, BIDV, Agribank -Vietnamese Bank for Agriculture and Rural Development, and ICB -Industrial and Commercial Bank of Vietnam);
- Five branches of foreign banks (including Natixis (France), ANZ (Australia), Credit Agricole (France), Bangkok Bank (Thailand), and BNP (France));
- Two Joint-Venture Banks (JVBs): Indovina with a 50-50 partnership between ICB and Cathay United Bank (Taiwan); and VID-Public Bank also with a 50-50 partnership between BIDV and Maybank (Malaysia), and;
- 24 JSBs with various ownership forms including private and public firms, cooperatives, peoples' committees, and individuals.

Despite participation of the private sector as well as foreign investors in the banking sector, the size of banking operations, as measured by the ratio of gross domestic saving (deposits) to gross domestic production (GDP), remained very small (see Table 2.1). In terms of the ratio of money supply M2 to GDP, even by the end of 1997 it only stood at about 28 percent which was far below the 128 percent for China and 90 percent for Thailand. The underdevelopment of the banking sector, low per capita income and restrictive monetary policy discouraged financial mobilisation (domestic savings) and consequently limited credit provision to the economy (Oh, 1999) (see Table 2.2).

Table 2.1: Financial deepening, end-1997 (%)

Items	Vietnam	Japan	Hong Kong	Singapore	Korea	China	Thailand	Indonesia	Malaysia
M2/GDP	27.6	143.8	205.7	93.1	48.3	119.6	89.9	57.0	116.9
Deposits/GDP	10.0	103.7	165.0	85.0	46.8	88.5	82.8	40.8	100.5
Currency/Deposits	42.7	11.8	3.7	9.5	7.8	15.1	8.4	12.1	8.5

Source: Adapted from Oh (1999)

Table 2.2: Gross domestic savings (% of GDP)

Economies	1992	1993	1994	1995	1996	1997
China	38.3	41.5	42.2	41.9	41.4	42.6
Indonesia	35.3	32.5	32.2	30.6	30.2	31.0
Korea	35.2	35.4	36.5	36.8	35.2	34.5
Malaysia	36.5	37.7	38.8	39.5	42.6	43.8
Philippines	17.0	15.2	17.0	16.8	18.8	19.2
Thailand	35.2	35.6	36.0	33.6	33.7	31.0
Vietnam	16.9	17.4	16.9	17.0	16.7	17.7

Source: Adapted from Oh (1999)

State-Owned Commercial Banks

SOCBs continued to dominate the banking sector even after its reform. At the end of 1997 they held 77 percent of total outstanding credit while non-state banks contributed only 23 percent (see Table 2.3). Since budgetary support for SOEs was significantly reduced after 1988 and a stock market had not been established, the provision of financial resources from the SOCBs became critical for the ongoing financing and production of SOEs. More than half of the credit from SOCBs was extended to SOEs (see Table 2.4). The remaining credit was mainly distributed to farming households and

a very trivial proportion of credit was extended to the non-farm private sector (Webster, 1999).

Table 2.3: Sources of Bank Credit

Year	Total bank credit		Credit extended by SOCBs		Credit extended by non-state banks	
	Amount (VND billion)	Percent	Amount (VND billion)	Percent	Amount (VND billion)	Percent
1994	33.345	100%	27.610	83%	5.735	17%
1995	42.277	100%	33.647	80%	8.630	20%
1996	50.751	100%	38.320	76%	12.431	24%
1997	62.201	100%	48.042	77%	14.159	23%

Source: IMF (1998; 2000)

Table 2.4: Distribution of bank credit

Year	Credit extended by SOCBs to				Credit extended by non-state banks to			
	SOEs		Non-SOEs		SOEs		Non-SOEs	
	Amount (VND billion)	Percent	Amount (VND billion)	Percent	Amount (VND billion)	Percent	Amount (VND billion)	Percent
1994	18.604	67.4	9.006	32.6	2.400	41.8	3.335	58.2
1995	20.855	62.0	12.792	38.0	3.224	37.3	5.406	62.6
1996	22.030	57.5	16.293	42.5	4.780	38.4	7.651	61.6
1997	26.625	55.4	21.417	44.6	4.597	32.5	9.562	67.5

Source: IMF (1998; 2000)

The allocation of a large proportion of loans from SOCBs to the SOE sector has manifested an intimate nexus. There are two approaches to explain this circumstance. First, a structural characteristic of the industry sector is its dominance by SOEs and three quarters of banking sector assets were held by SOCBs during the 1990s (Oh,

1999; Beresford, 2008; WB, 2012). Since the dependence of SOEs on financing through the state budget was eliminated in 1988 and a stock market had not been established, the role of banks in providing financial resources to SOEs was crucial to their development as well as for the overall development of the Vietnamese economy. Second, and originating from institutional factors, the government remained in favour of a leading role for SOEs in the economy (Kokko and Sjoholm, 2000). As a result the government was decisive in prioritising the allocation of credit from SOCBs to support SOEs as a part of its economic development strategy (Moreno *et al*, 1999; Gates, 2000; Harvie, 2004). The intimate relationship between SOCBs and SOEs adversely affected the strength of the banking sector in several ways (O'Connor, 2000; Kovsted *et al*, 2005).

- A characteristic of SOEs is their inefficiency. A dominant proportion of SOEs (60 percent) were unprofitable, while their debt-to-equity ratio reached 1.94 in 1997 (WB, 1998). The persistently poor performance of SOEs resulted in difficulties in servicing their debts which caused a deterioration of the balance sheets of SOCBs.
- The high concentration of SOCBs' loans given to SOEs resulted in a higher share of non-performing loans (NPLs) in their lending portfolios. At the end of 1997 the rate of overdue loans to the total loans of SOCBs was 8.2 percent, whereas this rate was only 7 percent for non-state banks[14].
- Interference by government at both the central and local levels relating to credit allocation implied that banks' staff with skills and knowledge of credit screening

[14] The author calculated this from the raw data of the SBV.

and monitoring became superfluous. Consequently, adverse selection and moral hazard turned out to be common in lending activities (Kokko, 1998).

The above-mentioned problem in the banking sector was viably observed in the first phase (1988−1997). Due to the close relationship between SOEs and SOCBs, reform in SOEs would be the precondition to conduct measures that increased efficiency and transparency in the banking sector (WB, 2000).

Joint Stock Banks

JSBs are private banks established by pooling the capital from shareholders who are individuals, private or state-owned companies. According to O'Connor (2000), there were three factors that contributed to the rapid expansions of JSBs in the mid-1990s. The first and most important was the process of financial liberalisation itself where the government issued regulations permitting private entities to enter the banking sector. Second, the government wanted to hold SOCBs accountable for their loan-losses; hence, they were more cautious when providing loans. The last factor was the desire of several SOEs to establish their own JSBs in order to ensure their own sources of finance.

However, the quality of these JSBs at that time was very weak and unsustainable. Many JSBs were established from the ailing credit cooperatives[15] in the early 1990s and some JSBs were founded by business families or a group of related SOEs, which were seen as influential shareholders (IMF, 1998). Moreover, undercapitalisation was a common

[15] Credit cooperatives (CCs) are credit institutions which are collectively owned. Playing the role as the sole funding source in local areas CCs mobilised the majority of local savings by offering very high interest rates. Nonetheless, these CCs began to encounter problems since the early 1990s. A number of CCs collapsed with billions of dong of unpaid deposits. A number of agricultural CCs had to close as government subsidies dried up. This panicked depositors. They rushed to withdraw their money causing most CCs to go bankrupt (Fforde and De Vylder, 1996).

characteristic of JSBs, as 70 percent of JSBs failed to meet the minimum chartered capital requirement set down by the SBV. In 1998, there were more than 40 JSBs operating in the banking market, but they accounted for only 7 percent of total banking sector assets.

JSBs were not only faced with difficulties in terms of financial capacity but also in terms of management capability. They were engaged in financing high-risk projects such as properties for residential development, which subsequently experienced a serious downturn. With the East Asia Financial Crisis (EAFC) of 1997-98 a bursting of real estate bubbles occurred and spread throughout the region including some of Vietnam's major cities. The JSBs were left exposed and some went insolvent when the collateral value of their clients plummeted (O'Connor, 2000). Furthermore, lending decisions were significantly affected by influential shareholders who had positions on the Board of Directors, and who encouraged extending credit to related parties (IMF, 1998; WB, 2000).

In general, the operation of JSBs during this phase exposed them to more risk resulting in high NPLs and insolvency. Intervention by the government and the SBV to improve the quality and increase the capability of JSVs had become a high priority.

Foreign Bank Branches

From 1991 Vietnam permitted the entry of foreign investors into the banking sector by establishing foreign bank branches. However, the operation of foreign bank branches was restrictive due to regulations imposed by the SBV which favoured domestic banks. For instance, the time length of business licences given to the branches of foreign banks was only 20 years. They could take Vietnamese dong deposits but only up to an

equivalent value of US$1.5 million. In addition, private enterprises in Vietnam were not allowed to collateralise land-use rights to borrow from foreign bank branches.

In summary, the weaknesses of the banking sector as highlighted above can be explained using several arguments. First, the existence of a dominant but inefficient state sector contributed to structural weaknesses in the banking sector. Second, both central and local government authorities interfered in the lending decisions of banks. Hence, lending policy became politicised and not determined on the basis of commercial viability. Other important reasons included the capability and competence of the SBV in conducting its roles as both the regulator and supervisor of the banking sector. These limitations needed to be solved to prevent a possible banking crisis and facilitate the longer term growth and development of the economy.

2.2.2 The Second Banking Sector Reform period (1998−2006)

In contrast with other countries in the East Asian region such as Korea, Thailand, Indonesia or the Philippines, the Vietnamese banking sector was spared much of the trauma arising from the impact of the EAFC. This was due to the absence of a liberalised capital account in combination with an inconvertible currency (Kovsted *et al*, 2005). The primary indirect impact of the EAFC was on enterprises which experienced deteriorating export earnings and a reduction of FDI capital inflows. Furthermore, Vietnamese enterprises had borrowed heavily in foreign currency as well as from commercial banks so as to take advantage of a low interest rate in a stable exchange rate environment. However, a ten-percent devaluation of the official exchange rate (the dong) to the US dollar in August 1998 worsened the condition of both enterprises and banks' asset quality.

To protect the state sector from the negative influences of the EAFC the government implemented favourable measures to assist SOCBs during 1998, including: (1) abolishing the requirement for SOEs to put up collateral when borrowing from SOCBs; (2) permitting SOCBs to lend to unprofitable SOEs; (3) writing off the bad loans of the SOCBs; (4) lowering lending interest rates; (5) and lengthening the loan maturity of troubled SOEs. These measures placed a heavier financial burden on SOCBs which were already struggling with many difficulties.

A combination of a three-year economic slowdown (1998−2000) and a fear of repeating the mistakes in other East Asian countries' banking sectors encouraged the government to commit towards a comprehensive and far-reaching reform of the banking sector. The scope of this reform covered several dimensions: (1) establishing a consistent and transparent legal and regulatory environment; (2) improving the quality of domestic banks; (3) and preparing for WTO accession.

Establishing a consistent legal and regulatory environment

The Law on the State Bank of Vietnam was approved by the National Assembly and promulgated in October 1998, defining the roles and functions of the SBV in implementing monetary policy as well as regulating credit institutions (WB, 1998). While the new law was believed to be a milestone in the development process of Vietnam's banking system or at least a first step in the right direction (Murray, 1999), Oh (1999) and Kovsted *et al* (2005) questioned the independence of the SBV. They supposed that the SBV was assigned as a ministry under the control of government, so that it must follow the government's decisions or even be interfered with in the conduct of monetary policy.

The Law on Credit Institutions also took effect at the same time, aimed at building a Vietnamese banking system with provisions on prudential operations and putting credit institutions on a legal basis to facilitate the conduct of monetary policy and stimulate economic growth (Hall, 2003). The role of credit institutions was described as being "contributors to a socialist-oriented, multi-sector market economy operating under the management of the state" (the Law on Credit Institutions 1998). Financial resources would continue to be favourably allocated to SOEs and cooperatives which played a leading role in the economy, as well as to poor and needy regions.

The two above-mentioned laws included regulations on the following items (Oh, 1999):

- Improvement of credit rules;
- Strengthening the legal framework for banks' loan collateral, mortgages and guarantees;
- Loan-loss provisioning;
- Credit line for clients;
- External debt management

Following the two laws there were 24 decrees which helped detail the contents in the laws (WB, 1998). These decrees pointed to three main goals: (1) providing quantitative regulations on banks' activities; (2) defining responsibilities of related parties in a credit relationship consisting of depositors, borrowers, and banks; (3) and providing the measures to enforce the borrowers' repayment obligations.

In order to increase the level of safety and stability in the banking sector in the aspects of deposit-taking, lending and portfolio investment, the SBV promulgated a series of quantitative regulations on commercial banks. These included the following:

- Increasing the chartered capital and limiting capital transfers;
- Imposing a minimum ratio on equities to assets at 5 percent;
- Liquidity ratio to at least three days of business repayment;
- Limitation of deposit-taking (not to exceed 20 times a bank's equity);
- The maximum credit amount to a client (not to exceed 15 percent of a bank's equity);
- The maximum credit to the 10 biggest clients (not to exceed 30 percent of total outstanding credit).

However, the regulatory framework did not impose an adequate requirement on loan classification and loan-loss provisioning which could build up a standard for identifying non-performing loans and financial sources to solve bad-loans.

In April 2005 the SBV issued Decision 493 on loan classification and provisioning[16]. The Decision was an important step towards bringing Vietnamese loan classification and provisioning practices up to International Accounting Standards (IAS) (WB, 2006; 2007). One of the differences between Decision 493 and IAS is that Decision 493 mostly depends on the quantitative assessment of the loan quality based on the number of days that servicing of a loan is overdue. Observers from the IMF and WB expected that it would take several years to transform the current standard of loan classification to the international qualitative standard based on the expected solvency of the borrowers.

Despite ongoing improvement of the assessment on loan quality under Decision 493, there remains a substantial gap in loan-loss provisioning as measured by Vietnamese Accounting Standards (VAS) and IAS. For instance, in 2004 and based on IAS the

[16]This Decision was subsequently supplemented by Decision 18 issued in 2007.

amount of loan-loss provisioning was estimated to be around 15 percent of the outstanding credit, but this figure was approximately halved from 8 to 10 percent when employing VAS after writing off bad debts (WB, 2007). This was less than many observers had expected but twice as high as the estimates based on the old VAS[17].

Improving the quality of domestic banks

The weakness of the banking sector during the 1990s was reflected in low profitability and inefficient financial intermediation (Oh, 1999; Hall, 2003). Moreover, the contribution of commercial banks needed to be enhanced to stimulate economic growth.[18] It was widely accepted that both SOCBs and JSBs needed to be restructured, but simultaneous restructuring both types of banks was impossible. This was due to the limited capability of both the SBV and government, and fears of losing control by the Vietnamese Communist Party over the banking sector made the restructuring plan piecemeal and cautious (Kovsted *et al*, 2005). Another important reason was the intimate relationship between SOEs and SOCBs, which required the restructuring plan of SOCBs to be conducted in parallel with the SOE reform plan. Consequently, the SBV chose JSBs to be restructured first and then SOCBs (WB, 1998).

The restructuring process involving JSBs was implemented in two steps. In the first step (cleaning up), depending on financial capability JSBs were classified into three groups: (i) strong banks which had a low level of NPLs, high liquidity, and a relatively high capital base; (ii) banks with a temporary lack of liquidity and moderate level of NPLs;

[17]Only from 2005 has data for the banking sector become more accurate and homogenous.
[18]Levine (1997) pointed out the relationship between development of the financial system and economic growth. Accordingly, a more efficient financial system would provide more loans and financial services that corporates can use in their production process. In Vietnam, the banking sector dominates the financial system, contributing up to 90% of the total assets of the system (IMF, 2014). Thus, the banking sector would substantially impact on Vietnam's economy.

(iii) banks with a persistent lack of liquidity and a very high level of NPLs. Strong banks in the first group were encouraged to be audited by IAS and improve their operations, corporate governance and develop new products and services for specific segments (Oh, 1999; WB, 2006). In contrast, the two other weak JSB groups were subject to strict measures imposed by the SBV. These JSBs were to be consolidated through the establishment of explicit and timely procedures for merging, or even closing non-viable banks. By the end of 2000, 13 of the 48 JSBs were placed under special supervision of the SBV; three banks' licences were revoked; two banks were merged (Kovsted *et al*, 2005).

The second step involved strengthening the financial capability of JSBs through loss allocation and increasing their capital (recapitalisation). To maintain the right incentives during the process of restructuring any losses were allocated first to shareholders, next to borrowers and eventually to large depositors. Current shareholders were given time to raise their additional capital to at least the minimum capital requirement (WB, 1998; Hall, 2003). If the requirements from the SBV were not satisfied the government would take control and close insolvent banks.

Restructuring SOCBs was more problematic than JSBs. Three reasons can explain this. First, the plan for restructuring SOCBs had to ensure that after restructuring SOCBs would lend only on the basis of commercial criteria and manage their business efficiently. The IMF and WB worried that as long as the government remained the sole owner of SOCBs, incentives for SOCBs to reform remained weak. Second, due to a predominant proportion of loans belonging to SOEs, and they were still in trouble, the restructuring plan of SOCBs had to go hand in hand with SOE reform. Third, any unrecoverable capital deficiency would be covered by the national budget.

Hence, the SOCBs restructuring process involved phasing out their policy lending, cleaning up NPLs, conducting IAS-applied audits and recapitalising (WB, 2007). Policy lending, which had been seen as a duty of the SOCBs, was transferred from them in 2004 to two specialised institutions: Development Aid Fund (DAF) and Bank for Social Policy (BFSP). DAF is responsible for lending to national economic programs while the poor and people in isolated mountainous areas received preferential credit from BFSP.

The resolution of NPLs was achieved mainly through writing off "policy" loans and frozen loans related to SOEs. However, these measures had not solved the causes of NPLs. The problem that SOCBs faced was that they had to improve their ability in screening and monitoring loans on the basis of profit orientation (WB 1998; IMF, 2000). A package of solutions was suggested including reorganising management, improving internal control, and training banking staff. Equitising SOCBs with the State being the predominant shareholder was another solution. The participation of a strong foreign bank playing the role as the strategic shareholder was anticipated to positively affect the performance of SOCBs. This is because foreign shareholders would help improve the management model and share their valuable expertise (WB, 2009).

Lastly, SOCBs needed to be recapitalised. A plan to address this issue, adopted from 2001, required Agribank to double its capital and for this to triple for the other SOCBs (WB, 2006). A capital amount equivalent to approximately 10 trillion Vietnamese dong was injected into the SOCBs to increase their equity during the period 2000−2005 (see Table 2.5).

Table 2.5: Relative size of SOCBs (trillion dong)

	Chartered Capital		Outstanding Loans	
	2003	2004	2003	2004
Four large SOCBs	14.53	17.37	214.80	296.07
Agribank	5.45	6.14	87.08	123.47
VCB	2.42	4.03	30.00	46.49
BIDV	3.75	3.87	48.09	64.01
ICB	2.91	3.33	49.63	62.10
DAF	4.98	4.98	64.81	76.93

Source: Adapted from World Bank Report 2006

Preparing for global integration

Vietnam submitted its first application to be a WTO member in 2002. After many rounds of negotiation Vietnam was accepted to be the 150th member of the world's largest trade organisation – WTO from January 2007. This event marked a milestone in the transition process of Vietnam, committing it to open markets to potential foreign competitors and to reduce and eliminate any subsidies and technical barriers to trade (WB, 2006).

In the banking sector technical barriers were to be gradually removed from 2007, and Vietnam committed to totally eliminating all obstacles applying to foreign investors from 2011. From April 2007 overseas banks were allowed to open 100 percent foreign-invested banks in Vietnam and joint-venture banks with a foreign capital contribution not exceeding 50 percent. Foreign banks were allowed to provide all services which were provided by domestic banks. However, during the first 5 years from the date of accession, Vietnam was permitted to limit the right of foreign bank branches to take

deposits in Vietnamese dong. The total equity held by foreign institutions and individuals in each of Vietnam's joint-stock commercial bank was limited to 30 percent of the bank's chartered capital.

Capital participation in the banking market by foreign investors generated concerns among the authorities on the competiveness of domestic banks. Both SOCBs and JSBs faced difficulties including low efficiency, out-of-date technology and a small size of capital. Consequently, WTO accession challenged domestic banks with foreign banks having high competitiveness, modern technology, and strong financial capability. Responding to this threat a strategy providing a comprehensive roadmap to improve the quality of the banking sector was issued through Decision 112 in May 2006 (WB, 2007). The main measures included the following:

- Elaborating a legal and regulatory framework

Two new laws, the Law of State Bank and the Law of Credit Institutions would be submitted to the National Assembly after 2007. Moreover, the Law of Deposit Insurance and the Law of Banking Supervision would be developed to ensure stability and public confidence in the banking sector.

- Strengthening the financial capability of domestic banks

Decree 141 issued in November 2006 identified the minimum capital requirement and a roadmap for domestic banks to implement. Accordingly, by the end of 2008 the minimum level of capital was 1000 billion Vietnamese dong rising to 3000 billion by the end of 2010. Any bank that could not satisfy these requirements would be specially supervised and stringent measures would be applied including bankruptcy.

- Increasing the quality of management

The SBV applied a modern joint stock corporation model to bank management including a Shareholder Assembly, a Board of Directors, and Internal Control. Independent auditing was obligatory in order to ensure a transparent environment and maintain the confidence of depositors. Foreign investors were offered to buy the shares of domestic banks. The participation of foreign investors with their expertise and high technology as members of the Board of Directors was expected to raise the efficiency of domestic banks.

- Developing banking technology

Domestic banks modernised their banking services based on information technology such as internet banking, automated teller machines (ATM), and payment cards. The SBV upgraded its electronic system for interbank settlement.

2.2.3 Accelerating after WTO Entry (2007−2009)[19]

The subsequent period after WTO accession was characterised by an acceleration of credit and assets in the banking sector. This rapid growth can be explained by several factors.

Liberalisation

Vietnam has to implement commitments on liberalising its banking sector. Foreign banks are allowed to provide their customers with all types of services such as acceptance deposits and other repayable funds from the public, lending of all types, financial leasing, all payment and money transmission services, guarantees and

[19] A detailed analysis of this phase will be presented in Section 2.3

commitments. Foreign credit institutions are permitted to establish a commercial presence in Vietnam.

Foreign banks with expertise, advanced technology, good trademarks and financial capability may establish 100 percent foreign-invested banks in Vietnam. Foreign banks may contribute up to 30 percent of shares in a domestic bank. The participation of foreign banks as dominant shareholders supports domestic banks. Through assigning their staff in the Board of Directors, and Board of Management, foreign banks can positively contribute to the decision making process in order to improve technology, quality of management, and develop new banking services and products (Claessens *et al*., 2001). Moreover, through capital participation foreign banks can facilitate the refinancing of domestic banks, helping these banks achieve the capital adequacy ratio imposed by the SBV.

At present there are two SOCBs with capital participation from Japanese banks. The first is Vietcombank which received US$567 million, equivalent to 15 percent of total equity, from Mizuho bank in 2011. In 2012 Vietinbank chose the third largest bank worldwide – The Bank of Tokyo-Mitsubishi UFJ (BTMU) as its strategic foreign investor. BTMU purchased 20 percent of Vietinbank's shares equivalent to US$743 million[20].

Large JSBs were even earlier than SOCBs in calling for capital participation from foreign investors. HSBC acquired a 10 percent stake in Techcombank in December

[20]Japanese banks are favoured by the Vietnamese government to be strategic foreign investors of SOCBs because Japan is the most important partner of Vietnam in terms of Foreign Direct Investment (FDI) as well as Official Development Aid (ODA). Through capital participation in SOCBs, Japanese banks drive the activities of these banks in order to support their clients (Japanese companies having businesses in Vietnam).

2005, and increased it to 15 percent in 2007. The International Finance Corporation (IFC) of the World Bank, ANZ Bank, and Dragon Financial Holdings jointly hold the maximum allowable of 30 percent of Sacombank, the biggest JSB in terms of chartered capital.

Financial deregulation

The SBV implemented a more expansionary monetary policy after WTO entry. Between 2001 and 2006 banking credit grew at an average rate of 28.5 percent in nominal terms. A considerable acceleration occurred from 2007 onwards (WB, 2009; Vo and Nguyen, 2009). When Vietnam officially became a member of the WTO capital inflows started accelerating in the form of FDI and portfolio investment. Concerning the related appreciation of the Vietnamese dong the SBV intervened in the foreign exchange market by purchasing foreign currency up to a value of 10.1 billion dollars in just one year (2007). Consequently, the banking system received significant additional liquidity. Moreover, an overheating real estate market with high expected returns attracted more credit from banks. The result was a ballooning of banking credit, peaking at an annual growth rate of 63.2 percent in nominal terms in March 2008.

An undesirable outcome in the post-WTO entry period was the venturing of economic groups from both state and private sectors into non-core business including banking, insurance and real estate (WB, 2009; 2012; Leung, 2010). This circumstance occurred during 2007 and early 2008 when these groups expected that mobilising financial resources would make substantial profits. In fact, the number of JSBs partly owned by SOEs increased from 4 in 2005 to 22 by 2010 (WB, 2012). The participation of business

groups in the banking sector reduced the efficiency of credit allocation when they channelled bank credit to themselves.

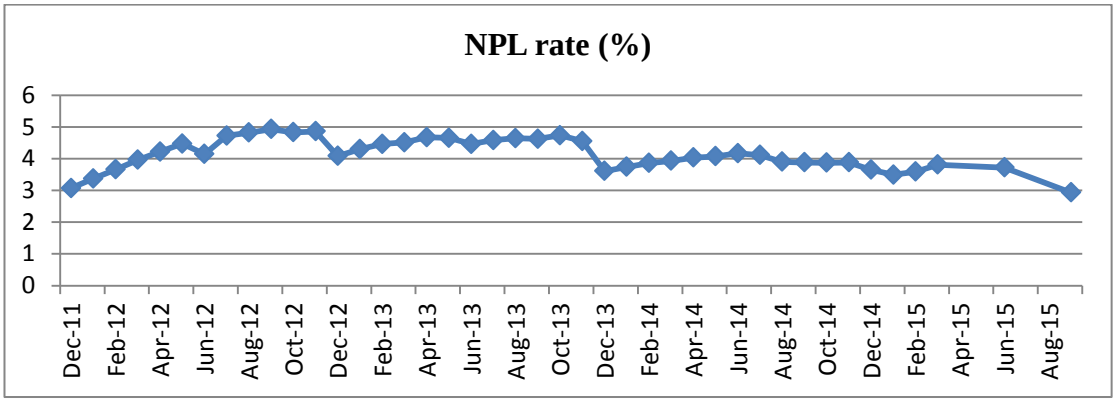
The SBV substantially loosened its regulations when permitting 12 rural banks to transform into urban banks during the period 2006-2007 (NAEC, 2012). In 2005, the total capital of these banks was estimated at 165 billion Vietnamese dong, or 13.75 billion dong on average for each bank. However, according to Decision 141 issued in May 2006, by the end of 2008 each urban bank had to achieve a chartered capital level of at least 1,000 billion Vietnamese dong. Consequently, transformed banks raced to increase their capital and they called upon capital contributions from the other big banks and business groups.

2.2.4 A Slowdown after the Global Financial Crisis and Restructuring the Banking Sector (2010−2015)

The past decade has recorded an extremely rapid expansion of the banking sector in Vietnam. The ratio of bank credit to GDP increased from 20 percent in the late 1990s to 136 percent at the end of 2010 (VELP, 2012). While credit expansion in the first half of the 2000s resulted from the financial deepening plan, in recent years, after WTO accession, it was the result of a loosening of monetary policy. In the context of a shallow financial market and weak governance, rapid credit expansion could result in banking system problems (Tornell, 1999; Keeton, 1999; Kawai *et al*, 2001). The quality of bank assets considerably deteriorated during this period. Non-performing loans surged during the 2010-2012 period as a result of a plummeting property market, defaults of SOEs and the impact of the GFC. There is no consensus on the NPL rate computed by different organisations (individual banks, the National Financial

Supervisory Commission (NFSC), SBV, and Fitch[21]). This is due to applying different accounting standards. According to a report conducted by the National Assembly Economic Commission, the rate of NPLs of the entire banking sector was between 10 to 12 percent at the end of 2011.This rate was estimated by credit rating agencies such as Fitch as being even higher at 13-15 percent. The SBV data indicated that it was 3.1 percent at the end of 2011; however, it increased to 4.8 percent in September 2012 (see Figure 2.1).[22] It has been documented that the banking sector is on the brink of a crisis and intervention by the government was seen as being imperative (Pincus, 2009; VELP, 2012).

Figure 2.1: NPL rate of the entire banking sector



Source: State Bank of Vietnam

Resolution No. 11 issued in February 2011 identified immediate measures to curb the high inflation rate and the extreme expansion of banking credit. It limited the growth rate of credit to under 20 percent and significantly reduced the fraction of lending to

[21] Fitch is a global rating agency dedicated to providing value beyond the rating through objective and balanced credit opinions, research and data (source: *https://www.fitchratings.com*).
[22] The large difference in the NPLs assessment can be explained by different accounting standards used. Individual banks and the Vietnamese authorities employ VAS while IAS is utilised by international credit rating agencies such as Fitch.

financial markets. The priority in credit allocation was to be to agriculture, small and medium enterprises and supportive industries.

Moreover, a long-run restructuring plan under Decision 254 was issued in March 2012. The overall objective of this was to restructure comprehensively the banking system with the 2020 vision to develop modern, safe, efficient, and sustainable banks capable of competing with foreign banks. In particular, in the period 2011-2015, emphasis was placed on improving financial conditions, safety, legal compliance, efficiency of banks and consolidating operational capabilities. A set of measurements has been drawn up, which includes:

Measures vis-a-vis SOCBs:

- SOCBs to keep up the pace of equitising but ensure that the State must hold the dominant share in these banks and develop from one to two SOCBs competing regionally.
- SOCBs raise their equity through additional public offerings and from budgetary resources in order to meet the Basel II capital standard by 2015.
- Solving and decreasing NPLs to below 3 percent according to the domestic standard by 2015.
- Improving internal control and supervision, especially the risk management system.
- Reducing the credit-to-deposit ratio to below 90 percent by 2015.

Measures vis-a-vis JSBs:

- Healthy JSBs will be consolidated to increase their sale and competitiveness in terms of size, service quality, administration, and technology. They are expected to support weak banks by increasing their liquidity, or through merging.
- In the case of temporarily illiquid JSBs the SBV will refinance them to ensure their liquidity. These JSBs are required to strengthen their financial condition, operations, and management under the close supervision and consultation of the SBV.
- Weak JSBs are defined as those banks that cannot ensure liquidity in either the short- or long-term. Their rate of NPLs is so high that the volume of NPLs exceeds their equities. In other words, they are technically insolvent. These banks will be refinanced by the SBV up to their level of chartered capital and put under special supervision. Their good assets should be purchased by healthy banks and they are put under special control, dividends and other payments are limited, weak banks are forced to merge and foreign investors are allowed to acquire or directly inject capital.

However, the government's bank restructuring plan exposed several limitations. First, although the plan provided a framework for comprehensive reform of the banking sector, the lack of implementation details implied that its application would be *ad hoc* and it suggested reluctance to close insolvent banks[23] depriving the authorities of an important coercive tool (IMF, 2012). The cost that must be paid by the economy would be bigger if the government was still indecisive in dealing with weak banks. Merging them together was no solution in itself and extending liquidity should only be to solvent banks. Second, the plan lacked regulatory and supervisory measures that would

[23] The SBV makes no distinction between illiquid and insolvent banks.

introduce specific and progressive enforcement measures to prevent problems leading to insolvency, as well as a special bank resolution and insolvency regime. This would prevent the possibility of a reversal of supervisory authorities' decisions by the court system, and protect them from personal liabilities. Third, to support supervision the regulations should have been strengthened in line with the best international practices, especially for loan classification and loan-loss provisioning.

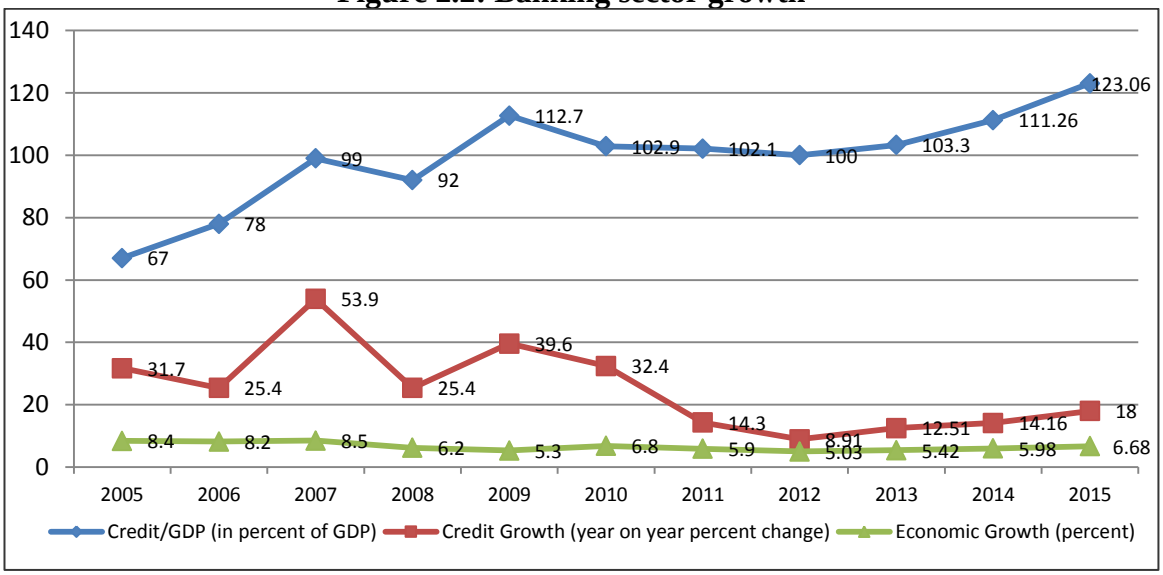
2.3 Vietnam's Commercial Banks in the Post-WTO Entry Period (2007−2015)

2.3.1 Performance of Vietnam's Commercial Banks

Rapid Growth

The immediate influence of banking liberalisation and deregulation has been the rapid growth of this sector in the post-WTO period. In 2001, banking credit accounted for only 39.3 percent of GDP, but it jumped up to 99 percent in 2007 and then to 125 percent in 2010 (see Figure 2.2). This compares with the period 2001−2006 where the average annual growth rate of bank credit was only 28.5 percent. A considerable acceleration occurred from 2007 to 2010, as the average annual growth rate increased to 37.8 percent. The restrictive monetary policy applied from 2011 imposed a ceiling on the credit growth of the banking sector to under 16 percent. As a result the rate of credit growth decreased significantly to 14.3 percent in 2011 and 8.9 percent in 2012.

Figure 2.2: Banking sector growth



Source: State Bank of Vietnam

The JSBs have achieved an even higher credit growth rate relative to the SOCBs, FBs and JVBs. In 2000 SOCBs dominated the banking system with a large share of the deposit market at 78.4 percent, but this rate continuously decreased to around 58 percent by 2007. The share of JSBs in the deposit market tripled during 2000−2007 reaching 29 percent in 2007. In the lending market in 2000 the size of credit provided by SOCBs was seven times higher than that of JSBs. Nonetheless, JSBs caught up with SOCBs by 2008 (see Table 2.6).

Table 2.6: Banking market shares (percentage)

	2000	2001	2002	2003	2004	2005	2006	2007	6 Months 2008
Deposit market share									
SOCBs	78.4	80.8	80.5	79.5	78.1	78.6	70	58	NA
JSBs	11.3	9.2	10.1	11.2	13.2	14.3	22	29	NA
JVBs and FBs	10.3	10	9.4	9.3	9.7	7.1	8	13	NA
Lending market share									
SOCBs	72	76	74	73	75	68	63	54	50
JSBs	11	13	15	15	14	16	27	38	50
JVBs and FBs	17	14	12	13	12	16	10	8	

Source: Adapted from Leung (2009)

Asset and Liability Structures

According to a report by NFSC(2012) the bulk of assets in Vietnam's banking system is in the form of loans including the "Placements with and Loans to other Banks" and "Loans for business and consumers" items, which accounted for 74 and 73 percent of the total in the two years 2010 and 2011 respectively (see Table 2.7). However, the share of total assets in the form of safe items such as "Cash and Balances with the SBV" contributed a very small part at 4 percent. This implies that the banking system is very vulnerable to shocks from related financial institutions, debtors, and markets. Changes to policies on the capital adequacy ratio, or minimum chartered capital would negatively influence banks with a very low level of liquidity and high NPLs. A downward trend in the stock or property markets would significantly deteriorate the asset quality of banks, which have a considerable proportion of their loans allocated to these markets.

Table 2.7: Structure of the banking system's assets(percentage)[24]

	2010	2011
Cash and Balances with the SBV	4	4
Placements with and Loans to other banks	21	22
Trading and Investment Securities	13	12
Loans for business and consumers	53	51
Investment	1	1
Fixed and Other Assets	9	10

Source: Adapted from the NFSC Report 2012, page 4

The inter-bank market has become more important in terms of financing for banks. In 2010 the share of "deposits and borrowings from other banks" item contributed only 16 percent of the total, but it surged to 21 percent just a year later. Meanwhile, the proportion of "Deposits from customers" decreased from 51 to 49 percent (see Table 2.8). The restrictive monetary policy conducted from the beginning of 2011 generated difficulties for banks to mobilise deposits from individuals and companies. Therefore, the inter-bank market became an alternative source of financing.

[24]Only the 2012 report of NFSC was published, the reports from 2013 onward have not been published.

Table 2.8: Structure of the banking system's liabilities (percentage)

	2010	2011
Due to Government and borrowings from the SBV	6	5
Deposits and borrowings from other Banks	16	21
Deposits from customers	51	49
Certificates of deposits	7	6
Equity	7	8
Others	14	11

Source: Adapted from the NFSC Report 2012, page 5

Profitability

Based on data provided by the banks the ROE (Return on Equity) and ROA (Return on Assets) achieved 14.26 and 1.12 percent in 2011, respectively. Comparing profitability using the ROE indicator amongst the different types of banks, SOCBs reached a peak of 18.01 percent, following by the JSBs (14.85 percent), and lastly the banking group consisting of JVBs and FBs (12.52 percent). However, the NFSC assessed that the reported data on profit from banks is not reliable and in most cases is underestimated. By adjusting data, specialists in the NFSC believed that the banking sector in 2011 suffered a loss equivalent to 49.693 billion VND instead of a profit of 118.769 billion VND as reported by banks.

In recent years the revenue of banks has become more dependent on lending activities. This is shown through the increasing trend of the ratio of loan-related revenues to total revenue. The ratio has continuously increased from 78.85 percent in 2009 to 83.98 percent in 2010 and 92.13 percent in 2011 (see Table 2.9).

Table 2.9: The ratio of loan-related revenue to total revenue (percentage)

Bank Groups	2009	2010	2011
SOCBs	86.38	89.95	92.13
JSBs	73.23	80.04	88.07
JVBs and FBs	65.59	66.44	71.83
Finance and Leasing firms	63.65	78.84	76.72
Average	78.85	83.98	89.13

Source: Adapted from NFSC Report 2012, page 25

Similarly, the capital adequacy ratio (CAR) is assessed differently between the data provided by banks and the adjusted data from the NFSC. According to the banks' reports the average CAR of the banking system was 11.56 percent in 2010 and 11.62 percent in 2011. However, this ratio only achieved 5.35 percent as assessed by the NFSC.

The gap between the above-mentioned data can be explained by the fact that banks have hidden their true NPLs through accounting practices, contributed to by problems of moral hazard. Consequently, their financial indicators are not accurate and are unreliable.

2.3.2 Ownership Structure

Before WTO entry the ownership structure of the SOCBs was absolutely dominated by the State, and the SBV played the role of State representative in these banks. The owners of JSBs were mostly individuals but also partly SOEs.

The post-WTO entry period witnessed a significant change in the structure of bank ownership. SOCBs were permitted to sell their shares to foreign and domestic investors

through privatisation. Currently three of the four big SOCBs have completed their equitisation, and two of them have chosen Japanese banks as strategic foreign investors.

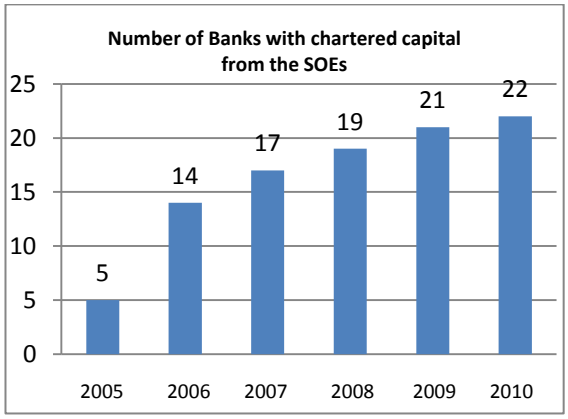
Policy makers and observers from international financial organisations (IMF, WB, and ADB) have expressed their agreement of this trend. Equitisation and capital participation by foreign investors force SOCBs to become transparent in their operation and commercially oriented in their objectives. Additionally, foreign banks will bring expertise, advanced technology and financial power that will support SOCBs to improve their management, strategy and banking practices.

Foreign capital participation not only occurs with SOCBs but also JSBs. There are a number of JSBs that have sold shares to foreign investors such as Techcombank, Asia Commercial Bank, and Sacombank.

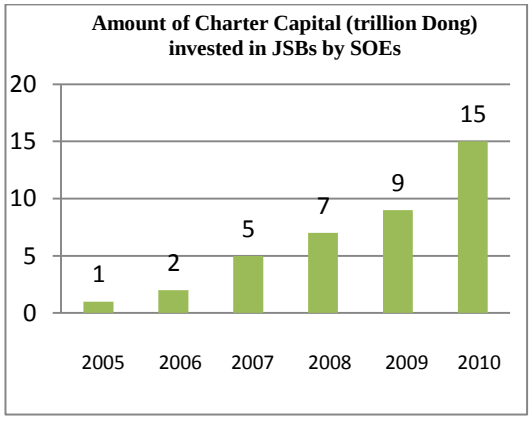
The number of JSBs partly owned by SOEs has steadily increased from the second half of the 2000s. In 2005, of 14 banks for which data on ownership is available, five had chartered capital from SOEs. The figure progressively increased to 22 by 2010 implying that three-fifths of JSBs had chartered capital from SOEs (see Figure 2.3 Panel A). The amount of SOEs' capital in JSBs has steadily increased from nearly 1 trillion in 2005 to 15 trillion Vietnamese dong by 2010 (see Figure 2.3, Panel B). In both aspects, the number of banks and the absolute value of their chartered capital and the presence of SOEs in the banking sector have been remarkable.

Figure 2.3: Number of JSBs with state chartered capital and amounts involved

Panel: A



Panel: B



Source: World Bank Development Report 2012

The capital participation and subsequent taking of control of JSBs by SOEs is risky and potentially jeopardises the stability of the banking system (Pincus and Anh, 2008; Pincus, 2009). The combination of commercial and financial interests under the same roof and the related-party transactions it supports has been repeatedly associated with economic crises in middle-income countries (WB, 2009). The experience of Chile in 1982-1983 and some East Asian countries experiencing the EAFC illustrate the risk involved. Crises in these countries were caused by excessively large investments, almost entirely funded by banking credit, in financial assets which eventually turned into bubbles. It is worth pointing out that the risk exists regardless of whether the commercial interests belong to the private or public sectors.

The involvement of SOEs in the banking system makes the economy more vulnerable due to their inefficiency in the use of resources, including capital. The last few years has recorded a dramatic acceleration in the capital and fixed asset of SOEs. The average capital per SOE surged from 130 billion dong in 2000 to 768 billion dong in 2008. During the same period average fixed assets and investments increased sixfold from 110

to 677 billion dong. Assets generated in the state sector were mainly financed by bank credit. SOEs are also found to be less financially prudent (Pincus, 2009). During 2007−2009 the debt-to-equity ratio of SOEs averaged 307 percent relative to 183 percent for non-state firms and 145 percent for foreign firms. However, SOEs have been proven to be very inefficient and wasteful in using capital and credit. SOEs use several times more capital to produce one unit of output than the industry average. In 2000 the average ratio of turnover to capital (a proxy of capital productivity) in SOEs was 1.6 compared to 8.8 for non-state enterprises. This circumstance was even more alarming in 2009. The turnover to capital ratio in SOEs fell to 1.1 while in private and foreign sectors it reached 21.0 in manufacturing industry (WB, 2012). It is obvious that while enterprises owned by the state are getting worse in terms of their efficient usage of capital, by contrast their private counterparts are becoming more economically efficient in their capital usage.

In the post-WTO accession period SOEs have, therefore, mobilised a significant amount of capital mainly through banking credit. Nonetheless, inefficient production, non-transparency and non-accountability in the state sector easily turned banking credit into NPLs over a short time period.

2.3.3 Effects of Asset Price Bubbles

The period 2007-2008 recorded a drastic increase in asset prices which were seen as dangerous bubbles (Pincus, 2009; Leung, 2009). There are two types of assets: stocks and real estate. In the first year of being a WTO member the stock market index in Ho Chi Minh City (VN-index) tripled in value from around 350 in 2006 to a peak of 1171 in March of 2007, and property doubled in price every few months. The former vice

minister of the Vietnam Ministry of Natural Resources and Environment – Dang Hung Vo stated that, on average, a Vietnamese citizen needs saving from 75 working years to buy a house[25].

The overheating growth of asset markets can be driven partly by the influence of WTO accession. The one remarkable influence of accession into the WTO is the substantial surge of foreign capital inflows from late 2006 (Leung, 2009). In 2007 alone a sum of foreign capital worth US$17.5 billion through channels such as Foreign Direct Investment (FDI), portfolio investment and Official Development Assistance (ODA) flowed into Vietnam. When remittances are added, total capital inflow reached US$24 billion dollars in 2007. Absorbing such a large capital inflow in a short period of time is not easy even for a developed country with mature financial markets. To keep the Vietnamese dong from appreciating relative to foreign currency the SBV bought the foreign cash inflows. Therefore, it injected dong into the economy which led to considerable excess liquidity in the banking system. This in turn resulted in a rapid growth of credit. In a shallow financial market like Vietnam it was anticipated that a significant fraction of credit would move into asset markets and fuel asset prices.[26]

The second argument to explaining asset price bubbles is the movement of large SOEs into the financial sector. These enterprises have broadened their business into non-core areas including banks, securities firms, real estate companies and insurers[27]. SOEs insist

[25] The source is from http://vef.vn/2012-01-31-trang-page-3

[26]Positive and normative theory of regulation can be applied to explain the relationship between credit growth and asset price bubbles in a shallow financial market such as Vietnam's. A lack of relevant regulations may result in high-risk investments by banks in the stock or property markets and this can lead to a spike in asset prices. Furthermore, the experiences of emerging countries such as Thailand or Indonesia during Asian Financial Crisis also show that rapid growth of credit fuelled speculative activity that resulted in asset price bubbles (Keeton, 1999; Kawai and Schmukler, 2001).

[27]For example, Petro Vietnam, the state oil and gas group, has six financial firms, two banks, security and real estate companies.

that they have only invested 30 percent of their capital outside of their core business (Pincus, 2008). Nonetheless, it is difficult to measure the extent to which the data is real and accurate. In a non-transparent environment large SOEs have the privilege of not being audited annually by independent audit companies and not having to publish their financial statements.

The influence of asset price bubbles on the banking system is extremely serious. Data on the size of loans in the stock and property markets has not yet been revealed, however according to VELP (2012) it would be very significant. Speculators raised the real estate and stock prices so as to achieve high capital gains. These actions will lead to bubble prices for assets. Therefore, under the upward trend of markets, the loans of banks are excessive and inefficiently allocated. On the other hand, when asset price bubbles burst these loans will be quickly turned into bad loans. The second negative effect of asset bubbles on the banking system is that approximately 70-percent of loans are backed by real estate as collateral. In the case where loans turn into NPLs and the banks have to liquidate collateral with a market value much lower than its book value, a significant proportion of loans will not be repaid.

2.3.4 Non-Performing Loans

International experience has shown that rapid growth in the banking sector under weak governance conditions will eventually result in instability of this sector (Gorton and Winton, 1998). Using the event method Demirguc-Kunt and Detragiache (1998) identify a set of indicators which determine the crisis status of a banking system. They are the ratio of non-performing assets to total assets in the banking system exceeding 10

percent; the cost of the rescue operation[28] of a particular country was at least 2 percent of its GDP; banking sector problems resulted in a large scale nationalisation of banks; extensive bank runs took place.

In Vietnam, where the predominant assets in banks are loans, the rate of NPLs to total outstanding loans can be used to replace the above-mentioned indicators. The true NPLs in Vietnam are difficult to identify due to conflicting outcomes from different related institutions[29]. Moreover, Vietnam is applying out of date accounting standards[30] in calculating NPLs which are considerably lower than that computed using ISAs. A report by the National Assembly Economic Commission declared that the rate of NPLs during 2010−2012 was between 10 to 12 percent (see Table 2.10). On the other hand, according to experts from international financial intermediates (IMF, WB) the rate of NPLs computed by the ISA is three to four times higher.

[28]The rescue operation funded by budgetary resources entails a number of measures to stabilise the banking system, for instance lending from central banks to ensure the liquidity of banks or recapitalisation of the banking sector (Demirguc-Kunt and Detragiache, 1998).

[29]The Fitch report "2013 Outlook: Vietnamese Banks" presented three very different assessments of NPLs. These are from the banks, the SBV, and Fitch.

[30]The new standards which seem to be closer to ISAs were supposed to be implemented but were postponed because they would immediately double or even triple the NPLs of banks, and quickly classify them as bankrupt. To keep the banking system in a "stable" condition the outdated standards are still in effect (IMF, 2014).

Table 2.10: Overdue and bad loans of Vietnam's banking system, 2010-2011

Indicators	**2010**	**2011**
Overdue Loans/Total Loans (%)	7.77	11.09
Of which (in percentage)		
SOCBs	10.43	13.36
JSBs	3.73	6.43
JVBs, FBs	4.66	5.76
Finance and Leasing Firms	21.06	40.85
NPLs/Total Loans (%)	2.29	3.72
Of which (in percentage)		
SOCBs	2.95	2.16
JSBs	2.3	1.87
JVBs, FBs	1.86	1.2
Finance and Leasing Firms	34.5	11.38

Source: Adapted from NFSC Report 2012, page 10

It is important to highlight the reasons which led to the high NPL rates. Pincus (2008) identified three immediate sources of vulnerability in the Vietnamese banking system. First, during the period 2005−2008 it was very easy to open JSBs or to transform rural to urban banks. The experiences from Argentina, Chile, and Indonesia show that when the government is not sufficiently selective in the awarding of bank licences then the result is the rapid growth of credit by inexperienced bankers, which are high risk takersand fail to diversify their bank assets. In reality, many small JSBs have used the bulk of their credit to purchase property and stocks. The NPLs rate is extremely high at

about 60 percent in some banks. The solution put forward by the SBV is to put these banks under special supervision and force them to restructure or even merge together[31].

Second, Vietnam allowed industry groups in both the state and private sectors to participate in and open banks. It repeated the mistakes of other countries such as Japan, Indonesia, and Chile when conglomerates employed banks as a source for funding their industrial and commercial projects. Subsequently, the allocation of credit became distorted when financial resources were not channelled to the most efficient projects. Third, Vietnam lacks a rigorous framework of regulation, supervision and enforcement to ensure a sustainable and consistent development of the banking system. Banking sector weaknesses that have persisted for a long time need to be effectively addressed by the SBV. Moreover, bad banks after having been identified and accused are not subsequently punished stringently and immediately. Therefore, the accumulation of negative behaviours in banks such as intra-lending, over-lending to the stock and property markets and moral hazard problems brings the banks to the verge of insolvency.

[31]See "The Scheme for Bank Restructuring Period 2011-2015" of the Vietnamese Government issued in March 2012.

Table 2.11: A summary of key policy changes by the Government since WTO accession

Changes	Type of Changes[32]	Source of Changes	Time
Allowing foreign banks to operate in Vietnam (in the form of 100% foreign-invested banks)	Liberalisation	Commitments from WTO accession	From April 2007
Allowing foreign banks to participate in domestic banks with capital (up to 30%)	Liberalisation	Commitments from WTO accession	2007
SOCBs Privatisation	Liberalisation	Decision 112 of the Government that requires SOCBs to be equitised	May 2006
Transforming rural banks to urban banks	Deregulation	Decree 141 imposed minimum bank capital that encouraged rural banks to transform into urban banks. The SBV loosened its standards for new urban bank entry.	November 2006
Allowing state business groups (SBGs) to participate in the banking sector	Deregulation	The IXth and Xth Vietnam Communist Party Congress allowed the formation of several pilot SBGs involving a multi-business model along the lines of the Korean chaebol (WB, 2012)	2005−2010

Source: Summarised and compiled by the author

[32] The policy changes are divided into two categories. The first incorporates changes relating to enhancing the participation of both the domestic and foreign private sector in the banking system (liberalisation changes). The second consists of those which allowed simpler and less stringent regulations for new bank entries (deregulation changes).

Table 2.12: A summary of differences in the business environment across different forms of bank ownership

Aspects	SOCBs	JSBs	FJVBs
Bank solvency	Solvency guarantee provided by the state	No guarantee	No guarantee
Accessibility to resources	Having privileges in terms of accessing financial or land resources	Having no such privileges	Having no such privileges
Scope of operation	Over the whole country	Over the whole country	Mostly focused in big cities such as Ho Chi Minh and Hanoi
Restrictions on operation	No restrictions and all types of banking services can be provided	No restriction and all types of banking services can be provided	Restrictions on banking services in Vietnamese dong has been gradually removed from the onset of WTO entry

Source: Summarised and compiled by the author

2.4 Summary

One important pillar of the Vietnamese strategy to transform the economy from a centrally planned to market economy from 1986 is through banking sector reform. The eventual objective of this reform is to build up a modern and efficient banking system which provides full and convenient services to consumers, producers as well as government. The transition in this sector has been conducted gradually and cautiously. Two barriers have limited the effectiveness of the reform plans; they are structural weaknesses and institutional irrationality. Structural weaknesses have been exposed through the persistent but inefficient presence of the state sector. SOEs have dominated the bulk of total credit from the banking sector and abused financial leverage. Inefficiently using financial resources and privileged access to banking credit resulted in a high level of NPLs. The government has tried to reduce the adverse effects of SOEs on the banking sector by their SOEs reform program, which accelerated from 1998. The program decreased significantly the number of SOEs and equitised most of the

remainder. Consequently, the operation of SOEs became more efficient and the rate of NPLs in the following period tended to decline. Nonetheless, in the post-WTO accession period (2007-present) a number of unsuitable policies have been issued which have contributed to widening the size of the state sector and made the banking system unstable. First, the government has permitted some large SOEs to transform their organisational model to that of business groups. These groups quickly established a series of subsidiaries which needed a substantial amount of credit with numerous privileges from government. Second, these groups and some large SOEs were allowed to expand their business into the banking sector through capital participation in operating banks or opening new banks. As a result it is not surprising that intra-lending became very popular for the banks which were partly owned by state enterprises. The existence of a large but inefficient state sector has negatively influenced the banking sector, an issue to be explored in more detail in Chapter 6.

The second very important factor that has affected efficiency in the banking sector is institutional irrationality. The decisions of government, SBV, or MOF (Ministry of Finance) are affected by the SEDPs of the Communist Party and interest groups (Pincus, 2008; Beresford, 2008). The consequence of this is that the SBV cannot conduct its roles as an independent regulator and supervisor of the banking sector, and the capability and efficiency of the SBV is undermined. Another irrationality of the SBV is that it cannot comprehensively control banks' activities. The overheating growth of financial markets such as the stock and real estate markets from 2007 attracted a significant amount of credit from banks. However, the function of regulating and supervising these markets has been allocated to the MOF. Weak cooperation between the SBV and MOF to control the capital flow from the banking sector into financial

markets resulted in an increase of speculative behaviour as well as moral hazard problems (NFSC report). Eventually, this has resulted in a low level of credibility from the market and the public and its faith in the government in general, and the SBV in particular, to conduct monetary policy. The limited information which the public has is always different from various sources of information. For political purposes this is because the SBV possibly intends to provide biased information, and is even not willing to provide some important information to the public who wish to have it. Policy actions have been inconsistent due to the gap between what the government announces and what they do. In other words, when the public has weak credibility of the SBV and government policy the banking sector is very vulnerable to external shocks.

This chapter has provided an overview of the Vietnamese banking sector and possible factors influencing the efficiency and stability of commercial banks in this country. It is necessary to put the situation of the banking sector in Vietnam in context. The next chapter reviews research on bank efficiency in the literature drawing upon the experiences of a number of countries.

Chapter 3: Literature Review on Banking Efficiency

3.1 Introduction

This chapter reviews methods used in previous studies to measure and analyse bank efficiency as well as the impact of financial liberalisation policies on bank efficiency. Both parametric and nonparametric methods used to measure bank efficiency are reviewed in this chapter. The scope of these studies includes not only those for a single country but also those for cross-country cases including countries at different stages of development (Maudos *et al*, 2002; Bonin *et al*., 2005a; 2005b; Kraft *et al*., 2006; Denizer e*t al*., 2007; Jiang *et al*., 2009; Berger *et al*., 2009; Chortareas *et al*., 2013). Of particular interest are those for transition economies specifically, of which Vietnam is one. A consensus from relevant studies is that liberalising the banking sector will improve banking sector performance in terms of technical efficiency (Levine, 2001; Hermes and Nhung, 2010; Chortareas *et al*., 2013). For transition economies an important finding is that a high efficiency level can be achieved rapidly if transitional banking systems transform to foreign dominated ones (Bonin and Schnabel, 2011).

The structure of this chapter is as follows. Section 3.2 summarises methods used in the literature to estimate bank efficiency including parametric and non-parametric types. Moreover, methods used to analyse the impact of environmental variables on bank efficiency are also discussed. Section 3.3 reviews studies on the impact of financial liberalisation on bank efficiency in a single-country or cross-country context. Section 3.4 provides an overview of bank efficiency in transition countries when these countries have changed the banking sector from one dominated by government ownership to one dominated by foreign ownership. Section 3.5 critically analyses previous studies on

bank efficiency and productivity in Vietnam, identifying gaps in this literature that this study will address. Finally, section 3.6 provides a summary of the major conclusions from this chapter.

3.2 Techniques related to Measuring and Analysing Banking Efficiency

3.2.1 Techniques for Measuring Banking Efficiency

Over the past several decades there has been substantial research effort on measuring the efficiency of financial institutions, and especially commercial banks (Berger and Humphrey, 1997; Fethi and Pasiouras, 2010). Measuring and evaluating the performance of banks is aimed at classifying those banks that are performing well and those that are performing badly (Berger and Humphrey, 1997). Based on the classification of "best practice" and "worst practice" banks, bankers can improve managerial performance by encouraging the former practices as well as discouraging the latter.

This section concentrates on the derivation of frontier efficiency which can assist in measuring how close a commercial bank is to a "best practice" frontier. There are two types of production frontiers; they are nonparametric and parametric frontiers.

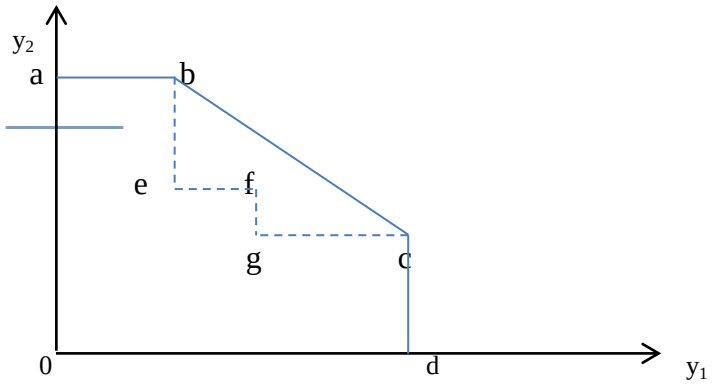
Nonparametric frontiers

The nonparametric approach is based on linear programming techniques which do not require specification of production functions[33]. Most research using this approach applies the Data Envelopment Analysis (DEA) and Free Disposal Hull (FDH) methods.

[33]The parametric approach uses regression techniques to estimate efficient frontiers, so that production functions need to be specified.

DEA is a linear programming technique for building efficient frontiers and measuring efficiency relative to these frontiers. The DEA technique involves forming a piecewise linear frontier that links a set of these best practice observations[34]. FDH is a special case of DEA proposed by Deprins, Simar and Tulkens (1984), where the efficiency frontier is built by connecting a set of DEA vertices and free disposal hull points interior to these vertices (see Figure 3.1).

Figure 3.1: A comparison between DEA and FDH



Source: Adapted from Deprins *et al.*(2006), page 3116

Note: A decision making unit (DMU) sample consists of five observations (b, c, e, f, g) with an output orientation, two outputs and one input and variable return to scale conditions. The efficient DEA frontier is constructed by a-b-c-d, while it is a-b-e-f-g-c-d in the case of FDH.

Fethi and Pasiouras (2010) reviewed a total of 196 studies and found that DEA is the most commonly used operational research technique in assessing bank performance. They identify a number of advantages from using DEA. First, DEA works well with small-sized samples so that it can be applied in any country. In most countries the number of operating banks is relatively small, ranging from tens to hundreds of banks except for the U.S.A which has thousands of banks. Second, DEA does not require any assumptions on the nature of the relationship between inputs and outputs and the

[34]A more detailed discussion of the DEA approach will be conducted in Chapter 4.

distribution function of inefficiency in order to determine the frontier. Consequently, DEA is simple and convenient for users.

Nonetheless, DEA also has a number of limitations (Coelli *et al*., 2005). DEA does not identify the measurement error and other noise which may influence the shape and position of the efficiency frontier. The exclusion or inclusion of only one input or output will lead to biased results. Moreover, treating inputs/outputs as homogenous commodities while they are heterogeneous may bias the result. In the DEA model only inputs and outputs are included while other managerial factors influencing the level of outputs generated from given inputs or the level of inputs used to produce a given output level are neglected. Thus, not accounting for environmental variables may give misleading indications of relative managerial competence.

According to Assaf *et al*., (2013), NPLs need to be included in a mix-production process to ensure the unbiasedness of results. The exclusion of bad loans in an efficiency measuring process would lead to biased outcomes because the more efficient banks can produce a higher proportion of undesirable outputs. There are a number of techniques that enable the incorporation of bad loans into DEA models. First, directional distance functions are based on the idea that a reduction of bad outputs is feasible only if good outputs are simultaneously reduced, given a fixed level of inputs. Second, slack-based measurement of inefficiency based on slacks including input excesses and output short-falls along with the computational scheme for defining efficiency. These two types of efficiency measurement can be combined with the network approach and dynamic approach in order to comprehensively measure bank efficiency including NPLs as a bad output (Fujii *et al*., 2014; Avkiran, 2015).However,

inclusion of bad loans in DEA models is impossible to conduct in this thesis due to unavailability of relevant data.

Parametric Frontier

The parametric approach uses estimation techniques to build an efficient production frontier based upon an assumed production functional form. According to Berger and Humphrey (1997), there are three approaches to building parametric frontiers: the Stochastic Frontier Approach (SFA); the Distribution Free Approach (DFA); and the Thick Frontier Approach (TFA). These approaches are similar at specifying the form of the production function. There are various forms that the production function can take: Cobb-Douglas, constant elasticity of substitution (CES) and translog. Nonetheless, they are different when it comes to assumptions about the distribution of random errors and inefficiency. The random error and inefficiency in the cases of SFA and DFA are assumed to be distributed following one of many types of distribution functions: half-normal, nonnegative, symmetric, or exponential functions. In contrast, there are no such assumptions in the case of TFA.

The DFA also specifies a functional form for the frontier; however, it separates inefficiency from the random error. This approach draws no strong assumptions on the distributional function of inefficiency or random errors. It supposes that efficiency is stable and the mean of the random error is equal to zero over time. Inefficiency can follow either a nonnegative or symmetric distribution form.

The TFA approach assumes a given specification of the functional form and that deviations from predicted performance values between the highest and lowest performance quartiles of observations indicate random error; and the deviations of

predicted performance between the highest and lowest quartiles represent inefficiency. This approach does not make assumptions about the distributional form of either the random error or inefficiency.

The advantages of using the parametric method are that it includes identification of measurement errors and random effects in the model, allowing estimation of confidence intervals as well as statistical inference of the efficiency scores. Nevertheless, this method also manifests several disadvantages. For example, it imposes a specification for the production function which may result in function misspecification errors. Since the method is based on estimation techniques it requires a large number of observations[35] to make the estimated results reliable (Simar and Wilson, 1998; Coelli *et al.*, 2005); hence the scope of this method is narrowed substantially and particularly for the case of small sample size.

3.2.2 Approaches to Analysing the Effect of Environmental Variables on Banking Efficiency

According to Fried *et al.* (1999) there are three approaches to analysing the effects of environmental variables on technical efficiency. They are the frontier separation approach, the all-in-one approach and the two-stage approach.

The Frontier Separation Approach

Charnes*et al*. (1981) was the first to use the frontier separation approach, specifically to analyse the effect of environment variables on managerial efficiency in U.S schools. Based on a single categorical variable that characterises the different environment

[35] SFA can be applied for measuring bank efficiency with large-size samples (for example: banks in U.S, or Europe).

conditions (e.g., ownership, gender), the data set is stratified into sub-samples. Nonparametric frontiers are solved for each sub-sample as well as for all observed data points. The effect of environment variables can be observed through comparing the efficiency scores of sub-samples and the pooled data.

Nevertheless, when the data set is divided into smaller sub-samples the efficiency scores tend to increase; consequently, the discriminatory power of the analysis is reduced. Furthermore, this approach has a problem in that it requires the environmental variables to be categorical ones.

The All-in-One Approach

In this approach all the external operating variables can be directly incorporated into a linear programming formulation along with traditional inputs and outputs. This approach allows an environmental variable not to be restricted to being a categorical one. The influential direction of the environmental variables needs to be prior identified before being included in the linear program (Fried *et al*., 1999; Coelli*et al*., 2005). If the variable is believed to be positive to the efficiency scores then it should be seen as a non-discretionary output. In contrast, it would be included as a non-discretionary input. However, the prior classification of environmental variables to be inputs or outputs is unsuitable if the objective is to investigate whether the effect of the variables is favourable or unfavourable.

The Two-Stage Approach

Regression of efficiency scores against a set of environmental variables are mostly based on the two-stage method. In the first stage the method involves calculating the efficiency scores with traditional inputs and outputs based upon an assumed production

functional form. In the second stage efficiency scores obtained from the previous stage are regressed upon a set of environmental variables. The influential direction of these variables on efficiency is determined by the signs of the coefficients.

Coelli*et al*. (2005) recommend utilising multivariate analysis in most cases due to its advantages against univariate analysis. The advantages are:

- More than one variable can be accommodated;
- Both categorical and continuous variables can be accommodated;
- Assumptions on the direction of variables are not necessary;
- One can test hypotheses on the significance of variables on efficiency;
- The method is simple and transparent.

However, there is a disadvantage with the two-stage method. If the input and output variables used in the first stage are highly correlated with the environmental variables, then in the second stage the estimates are likely to be biased.

In the DEA context there are three regression methods that have been used in the second stage. Two of these are ordinary least square (OLS) and Tobit; however, both methods also experience a bound problem. OLS could predict efficiency scores greater or smaller than the bound - unity (Coelli*et al*, 2005). Tobit allows regressing one-value efficiency scores on explanatory variables, but in fact they cannot equal one when the true efficient frontier is unobservable. A more serious problem is that both OLS and Tobit methods generate serially correlated efficiency scores.[36] Hence, statistical inferences resulting from these two regression methods are invalid (Xue and Harker, 1992; Hirschberg and

[36] The best practice DMUs in the sample are given efficient values of one and the inefficient others obtain their efficiency scores by comparing their performance relative to the best observations. Subsequently, DEA estimates are dependent and serially correlated.

Lloyd, 2002). Moreover, Simar and Wilson (2007) suppose that no studies employing either Tobit or OLS regression describe a data generating process (DGP). Therefore, the coefficients obtained in the second stage are not reliable. To overcome these problems Simar and Wilson (2007) propose a third method, the so-called truncated regression in two algorithms. The Monte Carlo simulation procedure reveals a preference for Algorithm 2[37] which helps correct for bias of the estimated coefficients (Delis *et al.*, 2011). Simar and Wilson (2007) start the procedure with a simple truncated regression, the estimates of which are corrected in a number of bootstrapping[38] steps.

3.2.3 Selection of Inputs and Outputs for an Analysis of Bank Efficiency

In order to measure bank efficiency, input and output variables need to be specified. There have been a number of approaches to choosing input and output variables in the context of measuring bank efficiency (Berger and Humphrey, 1997; Worthington, 2000; Das and Ghosh, 2006; Arjomandi *et al*., 2011; 2012). First and foremost, banks are financial intermediaries which link lenders to borrowers (**Intermediation approach**). To mobilise deposits from households and firms, banks hire staff and invest in fixed assets such as offices, software, hardware and other equipment. On the other hand, banks need staff, fixed assets and deposits to lend to firms and individuals which eventually generate loans. Furthermore, through the stock market, banks provide capital by purchasing securities which are issued by firms. Banks also finance themselves in the form of investments in associated companies. In general, in the context of the intermediation approach, the input variables consist of labour cost, value of fixed assets,

[37]The algorithm will be explained in detail in Chapter 4.

[38]Efron (1979) introduced the concept of "Bootstrap", which works satisfactorily on a variety of estimation problems. The bootstrap is a statistical technique for making inferences of certain estimates. Based on an original sample, a bootstrap generates a magnitude of pseudo samples (bootstrap samples) which will build the empirical distribution function of the given statistics.

and deposits. The output variables include loans, securities and investment. However, there is still controversy over whether a deposit should be classified as an input or output variable (Das and Ghosh, 2006).

A variation of the intermediation approach is the **value-added approach**. Asset and liability items that have a significant impact on value added are used as outputs. Application of the value-added approach requires identifying the major categories of deposits (demand, time and savings) and loans (for real estate, business, and instalments) as outputs. Purchased funds such as large certificates of deposits, foreign deposits, and other liabilities for borrowed money are treated as inputs (Berger *et al*., 1987). Using the value-added approach, Das and Ghosh (2006) use employee expenses, capital related operating expenses, and interest expenses as inputs producing outputs such as deposits (demand, saving, and fixed deposits), investments, and loans. Lozano-Vivas *et al.* (2002) applied the value-added approach to estimate efficiency of ten European banking industries using loans, deposits, and other earning assets as outputs and two inputs including personnel expenses and non-interest expenses.

An important responsibility of banks is to provide retail banking services to their customers, which include demand and time deposits, instalment loans, mortgage loans, business loans, and securities. The **production approach** is based on this responsibility and facilitates the estimation of banking efficiency scores. Physical variables (such as number of employers, number of computers) are used to estimate banking efficiency. The volume of services provided can be measured by the number of accounts, number of transactions, average number of instalment loans outstanding, or activity items (cheques, deposits, and transit items) (Benston, 1965). Inputs also include wages per employee and number of banking offices. Due to the fact that bank branches are where

retail banking activities occur and the clients are served, the production approach is most frequently used to estimate the efficiency of bank branches (Berger *et al*., 1997).

Banks can be seen as a specific type of enterprise earning profit through intermediating between lenders and borrowers and providing banking services (Leightner and Lovell, 1998). Banks receive revenues (or incomes) from services provided to customers. There are two types of revenues which are interest and non-interest incomes. Equivalently, there are two types of expenses including interest and non-interest expenses. The approach to using these variables based on the function of banks as profit earners is called the **operating approach**. A study on Malaysian banking efficiency in the post-EAFC period and conducted by Sufian (2009) employs the operating approach. The inputs are interest and non-interest income, and the outputs are interest and non-interest expenses. Das and Ghosh (2006) used interest expenses, employee expenses, and capital related operating expenses as the inputs and interest income, non-interest income as outputs in analysing the efficiency of Indian banks during the post-reform period.

According to Berger and Humphrey (1997) the two dominant approaches for selecting inputs and outputs are the production approach and intermediation approach. Nonetheless, neither of these two approaches is perfect, as neither of these approaches can capture the dual roles of banks as providers of transaction/processing services as well as being financial intermediaries.

Sathye (2003) found that the intermediation approach is frequently used in DEA studies. Moreover, this approach is commonly used together with other approaches such as the value-added approach, or operating approach. Das and Ghosh (2006) employ simultaneously the intermediation, value-added, and operating approaches in one study.

Banker *et al*. (2010) estimate Korean banking productivity using both the intermediation and operating approaches.

There is no consensus on the results from estimated efficiency scores using the different approaches. Berger *et al*. (1997) compare the production and intermediation approaches by applying the same data base of bank branches. The result is that the correlation index between the technical efficiency scores obtained from the two approaches is relatively low at 0.40. In another study the estimates of technical efficiency were consistently higher under the value-added approach than that of the intermediation and operating approaches (Das and Ghosh, 2006).

3.3 Impact of Financial Liberalisation on Banking Efficiency in a Global Context

The world has experienced a continuous and wide integration process of national economies in general and financial sectors in particular (Coleman and Underhill, 2012; Balassa, 2013). Since the 1990s governments in newly emerging market and transition countries have intensified policies towards liberalising their financial sectors (Hermes and Vu, 2010). The aim of financial liberalisation is to eliminate government control and intervention in the financial system of an economy. As a result the financial system becomes more competitive and efficient, but also subject to greater probability of a financial crisis (Radelet and Sachs, 2000; Claessens and Laeven, 2003; Reinhart and Rogoff, 2008). Nevertheless, financial liberalisation itself cannot guarantee financial sector efficiency and soundness without the necessary supervisory framework in place. Lessons from the East Asia Financial Crisis in several Asian countries such as Thailand, Indonesia and Korea indicate that financial freedom can lead to rapid credit growth, rising bad debt, asset price bubbles and eventually the onset of financial crises

(Radeletand and Sachs, 2000). Hence, financial liberalisation needs to be conducted in parallel with strengthening the supervisory and regulatory framework.

The term financial liberalisation covers a number of measures: autonomy of the Central Bank from government; free capital flows with the exception of short term capital flows ; elimination of interest rate or exchange rate controls; abandonment of policy lending to priority sectors; and removal of restrictions on bank ownership (Demirgüç-Kunt and Detragiache, 1998; Levine, 2001; Chinn and Ito, 2008). In the case of newly emerging market and transition economies where governments have stringently controlled financial systems further measures of financial liberalisation include opening markets for foreign entry and private investors and privatising state owned banks (Abarbanell and Bonin 1997; Zoli, 2001; Bonin and Wachtel, 2003).

According to Berger and Humphrey (1997) the primary goal of financial liberalisation and deregulation is to improve the efficiency of banks or intermediaries as well as their financial sustainability. Nevertheless, the outcomes are different depending on macroeconomic instability and in some cases banking crises triggered by overly ambitious financial deregulation (Denizer *et al.*, 2007). The rest of this section will be used to review the impact of financial liberalisation on banking efficiency in different economies and by stage of economic development (emerging, developing and developed).

Global financial liberalisation experience

Most empirical studies find that liberalisation of the banking sector improves efficiency in a wide range of countries, from developing and transition countries to developed

countries (Boubakri *et al.*, 2005; Hermes and Nhung, 2010; Chortareas *et al*., 2013).[39] For example, Ataullah *et al.* (2004) used DEA with two input-output specifications to compare the technical efficiency of commercial banks in India and Pakistan during a period of financial liberalisation from 1988 to 1998. Numerous measures were conducted to deregulate the banking system including a gradual deregulation of interest rates, reduction of reserve requirements, entry of non-bank financial institutions, allowing the entry of private banks (domestic and foreign); gradual abandonment of state-directed credit policies. They found that these measures positively impacted the overall technical efficiency of the banking sector, especially after 1995. Chen *et al.* (2005) and Kumbhakar & Wang (2007) investigated the efficiency and productivity of Chinese banks in the 1990s before accession to the WTO in 2001. The 1990s witnessed reform in the banking sector when the central government deregulated interest rates, eliminated local government intervention in SOCB lending and allowed entry by privately owned banks (only domestic investors). These policies generated pressure on the SOCBs to innovating their activities and services and become more commercially oriented. This resulted in a modest improvement in banking efficiency and productivity.

After the collapse of centrally planned economies in Central and Eastern Europe at the end of the 1980s and early 1990s, a number of these transition economies implemented a "big-bang" reform in the banking sector by privatising state owned banks and permitting the entry of foreign banks. Due to political issues Croatia initiated banking reform and liberalisation later than other transition countries[40]. Kraft *et al.* (2006) conducted research on the impact of banking liberalisation in this country during the

[39] For a summary on the impact of financial liberalisation on bank efficiency in a global perspective, see Table 3.1.
[40]Croatia only became an independent country in October 1991

period 1994–2000. Using the SFA approach to estimate a Fourier-flexible frontier cost function the authors showed that an increase in bank efficiency is not immediate with privatisation, but only for new foreign banks with good management and reputation[41]. In contrast, Hungary, as a transition economy during the period of the late 1980s and much of the 1990s, started banking reform and liberalisation relatively early when the government accepted several foreign banks to establish business activities in the early 1980s (Hasan and Marton, 2003). Adopting the SFA method and a translog production functional form, Hasan and Marton (2003) estimated the profit and cost frontiers for banks during the period 1993−1998. They found that foreign banks outperformed domestic banks in Hungary and their capital involvement with local banks facilitated an improvement in their efficiency. Foreign entry and privatisation with flexible approaches were effective liberalisation measures in order to pave the way for a stronger banking sector in a short period of time.

The difference between developing and transition countries with developed countries is that the latter have mature institutions and a transparent business environment. These conditions ensure that policies focusing on financial liberalisation would be conducted effectively to improve banking efficiency. Sturm and William (2004) compared the efficiency of Australian domestic banks to that of foreign banks in the post-deregulation period 1988 – 2001. Both DEA and SFA methods are applied to measure efficiency. The DEA results found that foreign banks experienced superior scale efficiency. The source of productivity gain was technological progress rather than technical efficiency improvement as a result of new technologies transferred from foreign banks. Even in a

[41]Kraft *et al.* (2006) measured the reputation of foreign banks by the asset size of their holding corporation and number of operating years .

liberal banking sector such as that in Hong Kong, an even more liberal policy can improve banking efficiency. Drake *et al.* (2006) using the DEA method showed that financial deregulation during their study period of 1995 – 2001, and involving the removal of remaining interest rate caps, increased the mean efficiency of Hong Kong banks.

In some cases the impact of financial liberalisation was not as expected by policy makers. There is evidence about the negative effects of the liberalising process on banking efficiency. Denizer *et al.* (2007) measured bank efficiency in Turkey using data covering a 25-year period from 1970−1994. The authors suggested that the resultant outcomes of opening up the financial market were not as expected by policy makers when they assumed that more highly motivated management would facilitate more efficiency in resource usage. Bank efficiency scores were found to have decreased and varied unstably against a backdrop of a turbulent macroeconomic environment. In terms of developed countries, Grifell-Tatje and Lovell (1996) investigated productive efficiency and total factor productivity change in Spanish savings banks in the post-deregulation period (1986−1991). This period witnessed all interest rates and service charges being liberalised and savings banks being permitted to open branches outside their traditional geographic regions. The productivity decline was caused by an expansion of branch networks creating costly excess capacity. Another example is Korea which implemented a set of financial liberalisation measures under a series of revisions to the General Banking Act from 1991 – 1997 (Park and Weber, 2006). Policy loans were abandoned, interest rates were liberalised, the exchange rate was deregulated and a restructure of bank ownership allowed individual shareholders a 12 percent equity

stake. However, these deregulations made the banks more inefficient in the years prior to the EAFC.

Several studies have shown mixed results from liberalisation measures on bank efficiency in the case of countries during a similar study period. For example, Berger *et al.* (2009) analysed the impact of foreign entry and involvement on banking efficiency in China in the pre- and post-WTO[42] accession period (1994−2003). They found that the Big Four[43] group were the least efficient due primarily to poor revenue and high NPLs, while foreign banks were found to be the most profitable and efficient banks. In contrast, research conducted by Jiang *et al.* (2009) found that joint-stock banks were the most efficient while foreign owned banks and city commercial banks were the least efficient. However, both studies advocated the positive impact of foreign involvement on banking efficiency in the long-run. Such conflicting outcomes for bank efficiency and productivity also appeared for the case of Spain during a deregulatory period (1986−1991), characterised by freeing interest rates, allowing saving banks to widen their networks, lowering reserve requirements and phasing out investment requirements. Maudos*et al.* (2002) analysed the influence of specialisation in services provided by banks to explain the cost efficiency difference between bank types during the period 1985−1996. Using DEA to estimate the production frontiers for specific bank types they found that the cost efficiency of saving banks experienced an appreciable improvement and that there was a positive correlation between the size of banks and their level of cost efficiency. In contrast, a decline in the productivity of Spanish banks was recorded by

[42]China joined the WTO in December 2001

[43] The Big Four group consists of the four largest state owned banks in China (Bank of China, China Construction Bank, Industrial and Commercial Bank of China and Agricultural Bank of China), and they held 77.1 percent of all banking sector assets in 2003 (source: Berger *et al.* (2009)).

Grifell-Tatje and Lovell (1996); moreover, there they found no apparent link between bank size and performance.

To explain such mixed results from financial liberalisation on bank efficiency, Kraft *et al.* (2006) supposed that differences in the regulatory and economic environment across countries are very strong so that the policies towards liberalising financial markets would result in different outcomes. Second, most of the studies are inconsistent when using just one or a few dimensions of financial liberalisation (Hermes and Vu, 2010). The solution to these limitations is to conduct research based on a cross-country comparison with data covering a set of countries at a similar stage of development such as developing or developed countries. Cross-country based studies all indicate a positive relationship between financial liberalisation and bank efficiency. For example, Casu and Molyneux (2003) investigated banking efficiency in leading European economies when the Single Market Program (SMP) was implemented in 1993. Implementation of SMP created the largest and most open banking market in the world through abandoning contemporary barriers by establishing minimum regulatory requirements across the European Union; accordingly, SMP could lead to a more efficient banking sector in Europe. It was found that there was a slight improvement of average efficiency scores over the period 1993−1997; nevertheless, the gap among countries grew even wider due to country-specific aspects relating to the adoption of banking technology. One other study by Chortateas *et al.* (2013) investigated the impact of financial freedom on bank performance in 27 European Union countries during 2001−2009. This was the first study to explicitly characterise the effects of "financial freedom" indices on bank efficiency by controlling for banking, economic, and institutional variables. The results showed a clear positive association between the financial counterpart of the economic

freedom indices and bank efficiency scores. Moreover, a higher level of economic and financial liberalisation would result in a relatively higher degree of efficiency on the cost side.

In the context of emerging market economies, Hermes and Vu (2010) used data consisting of 4000 bank-year observations from 10 countries in Latin America and South East Asia in the period 1991−2000. The index developed by Laeven (2003) included six aspects: interest rates, entry barriers, reserve requirements, credit controls, and privatisation and prudential regulation was employed to measure the degree of financial liberalisation. The results from the empirical analysis strongly supported a positive impact of financial freedom programs on bank efficiency. Hence, studies based on cross-country samples have generally found a positive relationship between financial liberalisation measures and bank efficiency.

3.4 Banking Efficiency in Transition Economies

3.4.1 An Overview of Bank Efficiency in Transition Economies

Before 1989 the banking system of transition countries consisted of a mono bank which acted as both a central bank and a commercial bank, and was designed to meet the needs of a centrally planned economy (Koivu, 2002). The collapse of the Socialist Bloc at the end of the 1980s triggered a transition process which transformed centrally planned economies into market economies. Consequently, the mono banking system was split into two tiers including a central bank and a number of commercial banks.

The importance of banking efficiency in transitional economies has been recognised in the literature. A number of studies have shown a close and positive relationship between

the level of banking efficiency and economic growth (Levine, 1997; Lucchetti *et al.*, 2001; Berger *et al*., 2004). Koivu (2002) investigated whether an efficient banking sector accelerates economic growth in terms of transitional countries. The study was conducted for 25 transitional countries during the period 1993−2000, and it provided support for the view that banking efficiency is very important for economic development. This is because an efficient banking sector allocates financial resources to the most profitable and productive enterprises. Gordon and Winton (1998) investigated the relationship between banking efficiency and banking instability. A paradox between the efficiency and instability of the banking sector in transition economies was discovered. When the banking sector operates efficiently it mobilises more deposits and lends more to the economy. Nonetheless, the state sector (mostly SOEs) still dominates many transitional economies but operating inefficiently generates high non-performing loans for banks. Subsequently, the banking sector would become vulnerable and unstable.

It is important to highlight specific characteristics of the banking sector in transition countries. There is evidence to suggest that these characteristics substantially influence banking efficiency (Weill, 2003; Bonin *et al.*, 2005a).

- First, the banking sector suffered structural weaknesses when the transition process began. The public sector dominated the economies of transition countries, but was inefficient in its operation. Consequently, governments had to conduct reform programs so as to increase the efficiency and competitiveness of the economy in general and the banking sector in particular (Fries and Taci, 2005; Chen *et al.*, 2005). Program measures included: rehabilitating SOCBs; permitting the growth and development of the private sector; liberalising and

opening the banking sector to foreign investors; conducting banking sector reform in parallel with SOE reform (Hasan and Marton, 2003; Haas and Lelyveld, 2006; Fries *et al.*, 2006). The results of reform have not been consistent across transition economies, and depend on specific country characteristics and approaches (models of transition, feasibility of programs, quality of institutions and speed of the reform process).

- Second, financial markets in transition countries have only been developing for just over 20 years (from the end of the 1980s to the present); hence, they are still shallow and narrowly based[44]. While in modern economies there are a wide range of financial institutions and derivatives to support economic growth, commercial banks have been the major source of finance in transitional economies (Bonin and Wachtel, 2003; Hasan and Marton, 2003). The underdevelopment of capital markets and non-bank financial intermediaries has burdened the commercial banks with having to provide long-term financing for corporate investment and supporting the mortgage market. Moreover, macroeconomic instability, such as high inflation during the transition process, distorted the structure and flows of deposits. High inflation rates eroded the value of deposits so that depositors reduced the maturity of their deposits or even transferred their saving to non-productive assets (gold, strong foreign currency, and real estate).
- Bonin and Wachtel (2003) suggested two pillars underpinning an efficient banking sector. The first is strong banks in terms of financial capability with

[44]Financial markets in transition and emerging markets are said to be shallow and narrowly based because of the small size of their financial sectors and the dominance of the banking sector relative to non-bank financial intermediaries (Zoli, 2001; Hasan and Marton, 2003).

good corporate governance aiming to improve efficiency. Second, is a consistent regulatory agency which regulates and supervises all banking activities. Most regulatory agencies in transition countries automatically apply western-style regulations which have been developed for hundreds of years in the U.S or European economies. Meanwhile, elements necessary for conducting these regulations such as the quality of staff and symmetric information between the bankers (or clients) and regulators are weak (Mitchell, 2001). Furthermore, non-transparency of the business environment distorts or stifles fair implementation (Zoli, 2001). It is certain that a regulatory and supervisory framework based on solid foundations contributes significantly to the efficiency and stability of banking systems in transition economies.

The last two decades have witnessed a substantial transformation from dominant state-owned to foreign controlled banking sectors in emerging market countries, including transitional ones. The transformation helps these transition economies surmount the above-mentioned characteristics and orient to market based banking sectors. The results brought about from the transforming process advocate government policies that open and liberalise banking sectors.

3.4.2 The Impacts of Financial Liberalisation on Banking Efficiency in Transition Countries

Studies of bank efficiency in the former transition economies in Central and Eastern Europe, former Soviet Union countries, or East Asia mostly focus on the impact of financial liberalisation in terms of bank privatisation and foreign involvement (see Table 3.2 for a summary). These studies have been conducted in both single-country

and cross-country cases. Both SFA and DEA methods have been employed to estimate efficiency scores.

The intermediation approach to efficiency analysis is commonly applied because the most important role of banks in transition economies is to transfer savings into loans. In several studies the intermediation approach is used together with other approaches such as the production or operating approach (Jing *et al*., 2009; Karas *et al*., 2010).

There is evidence to suggest that foreign bank entry has a positive impact on bank efficiency in transition countries. Studies conducted in single-country cases support foreign banks outperforming domestic banks. Havrylchyk (2006) investigated the efficiency of the Polish banking industry between 1997 and 2001 using the DEA method. The author found that inputs were employed more efficiently and the right mix of inputs was chosen in foreign banks. In line with other research conducted in other transition countries, foreign banks exhibited higher efficiency than domestic banks due to the successful performance of greenfield foreign banks. Other studies conducted in Russia (Karas*et al.*, 2010), Croatia (Kraft *et al.*, 2006) and Ukraine (Kyj and Isik, 2008) also found that foreign banks had advantages in terms of corporate governance, risk management, financial capability as well having a sound reputation of utilising inputs optimally and more efficiently in allocating credit to firms and individuals. Consequently, they achieved the highest efficiency in comparison with domestic banks.

Studies based on cross-country comparisons give more consistent results to that of studies with a single country focus. However, the results are mixed depending on the study period or the geographical scope. For example, Fang *et al.* (2011) estimated the efficiency of six South East European countries from 1998 to 2008 and found that

foreign owned banks were less cost efficient but more profit efficient than domestic banks. In contrast, Yildirim and Philippatos (2007) show that foreign banks achieved higher cost efficiency but lower profit efficiency in a sample consisting of 12 countries in Central and Eastern European countries from 1993−2000. On the other hand, Kasman and Yildirim (2006) showed a consistent superiority in terms of both cost efficiency and profit efficiency for foreign banks when measuring bank efficiency in eight Central and Eastern European economies during the period 1995−2002.

There are two types of foreign banks. The first are greenfield banks, which have been established as new entities by foreign investors. The second type, so-called takeover or foreign-acquired bank, resulted from the acquisition of former domestically owned institutions during the privatisation process. Although these two types of foreign banks are totally owned and managed by foreign investors, their level of efficiency is dissimilar. Results from research conducted by Havrylchyk (2006) indicated that greenfield banks achieved higher levels of efficiency than domestic banks, and takeover banks failed in enhancing their efficiency. With respect to both cost and profit, foreign greenfield banks are the most efficient of all bank types in six transition countries in a study conducted by Bonin *et al.* (2005b). Poghosyan and Poshosyan (2010) investigated the influence of foreign bank entry in the banking sectors of 11 transition countries (1992 – 2006), and concluded that foreign greenfield banks experienced superior efficiency in comparison to that of domestic or foreign-acquired banks. The reasons are argued by the fact that greenfield banks inherited overseas customers of their parents banks operating in the same host countries. Moreover, the efficiency of takeover banks did not improve significantly at the early stage of foreign entry as a result of poor managerial and financial characteristics of the targeted banks. Foreign investors are not

only permitted to establish totally foreign-owned banks but also to participate their capital in domestic banks. In some transition countries foreign investors are allowed to be majority owners of domestic banks. However, foreign investors commonly hold a percentage that exceeds 50 percent of domestic bank equity (these banks are so-called majority foreign banks). On the other hand, transition countries in Asia such as China and Vietnam impose an upper bound on capital participation from foreign entities. The bound is generally below 50 percent of bank equity to ensure that domestic shareholders can take control of these banks (these banks are so-called minority foreign banks, see Berger *et al.*, 2009). In both mentioned bank types private banks with foreign involvement have been shown to achieve higher levels of efficiency than domestic private banks or state-owned banks. Fries and Taci (2005) empirically examined the efficiency of 289 banks in 15 post-communist countries in East Europe and found that private banks were more efficient than state-owned banks. However, there was substantial dispersion amongst private bank groups. Privatised banks with majority foreign ownership were the most efficient. In a single country study conducted by Hasan and Marton (2003) in Hungary, they showed that in the short-term policies towards enhancing foreign involvement in domestic financial institutions facilitated the way for a stronger banking sector. Among foreign-involved banks a higher share of foreign ownership was associated with a lower degree of inefficiency. The positive influence of foreign involvement not only stemmed from majority foreign ownership but also minority foreign ownership. Berger *et al.* (2009) showed that for both profit and cost efficiency as well as for both categories of domestic banks with minority ownership (private and state-owned banks); minority owned foreign banks are

associated with higher efficiency. In addition, this result is robust after checking for selection effects that efficiency improved after foreign investment.

At the early stage of transforming the banking system in transition economies, state or government ownership has dominated the banking sector. Nonetheless, this type of ownership is recognised as an encumbrance for improving the efficiency and profitability of banks (Zoli, 2001; Hasan&Marton, 2003; Havrylchyk, 2006). This is due to the fact that governments tend to orient the banks they dominate in terms of ownership to a policy rather than commercial orientation (La Porta *et al.*, 2002). As a result, decreasing substantially or even eliminating government ownership is seen to be a critical policy towards improving the efficiency and productivity of the banking sector. Cross-country studies conducted by Fries and Taci (2005), Bonin *et al.* (2005a; 2005b), Fries *et al*. (2006) together advocate that private banks are superior to state-owned banks in aspects of both cost and profit efficiency. Moreover, single-country studies conducted in China (Jiang *et al.,* 2009; Berger *et al.,* 2009) and Bulgaria (Tochkov and Nenovsky, 2011) also support the outperforming of private banks to public banks. Nonetheless, several studies have shown a reversed relationship between state ownership and bank efficiency. Karas *et al.* (2010) investigated bank performance in Russia and showed that there were no differences between private and public banks in terms of technical efficiency. Yao *et al.* (2009) measured Chinese bank efficiency and productivity during the period 1998−2005 and concluded that large privatised state-owned banks achieved higher technical efficiency and productivity after their IPOs (Initial Public Offering).

Bonin and Schnabel (2011) describe a great transformation from government-owned to foreign controlled banking sector and that this is an unprecedented change in banking

systems to have occurred in transition economies. The shift to market-based operations is accompanied by an improvement in the financial environment generally, and bank efficiency in particular.

3.5. Literature on Banking Efficiency in Vietnam

To the best of the author's knowledge, Nguyen (2007) is the first study to investigate the efficiency and productivity of Vietnamese banks covering the period 2001−2003 with a limited sample of banks (13 of about 50 commercial banks). Using a basic DEA method he found that the average bank cost efficiency score was a low 60.6 percent and the sources of this inefficiency derived from both allocative and technical components of cost efficiency. The Malmquist productivity index decreased during the period 2001−2003. However, the results do not reflect the entire banking sector due to the short period of the study as well as the small sample size. Moreover, the period 2001−2003 witnessed a significant change in the banking sector such as the recapitalisation of the SOCBs, and the merging or even revoking of the banking licenses of small Joint Stocks Banks (JSBs) after the East Asia Financial Crisis (EAFC). Nonetheless, the determinants of banking efficiency and productivity were not mentioned or determined in the study.

Quang and De Borger (2008) used a bootstrap technique to construct confidence intervals for DEA-based efficiency and productivity of the Vietnamese banking sector for the period 2003-2006. The technical efficiency scores were very high at 94 and 95 percent in 2003 and 2004, respectively; and then substantially declined to 85 percent in 2006. Nonetheless, such a high level of efficiency is doubtful. A suitable reason is that the sample of banks does not include the small rural banks which were seen to be

inefficient in their operation. The state-owned banks were found to be more efficient than private banks. However, the explanation provided on this comparison in the study is weak with no empirical evidence provided to support it.

Minh *et al.* (2013) estimated the efficiency of Vietnam's banking sector using a sample of 32 banks during the period 2001−2005. They used a super-efficiency measure through a slacks-based model under the assumption of variable returns to scale (VRS). The average efficiency score was found to be about 80 percent during this period, and it tended to increase. Furthermore, a set of determinants were emphasised including ownership type, bank size, labour quality and market share through a Tobit model regression. They found that state ownership negatively affected efficiency. Nonetheless, this result was not consistent because the SOCBs were recorded as achieving a high ranking during 2001−2005. A positive relationship between efficiency and bank size and market share was also found.

Vu and Turnell (2010) firstly employed an SFA method to measure bank efficiency in the context of Vietnam. The bank sample in this study covered almost all banks and foreign-bank branches operating in Vietnam during the period 2000−2006. The authors concluded that, on average, cost efficiency was mostly unchanged and SOCBs reached a higher efficiency level than private banks (JSBs and foreign-bank branches). The authors argue that the improvement of SOCBs' efficiency resulted from the implementation of the Overall Restructuring Framework which aimed to recapitalise and phase out policy lending by the SOCBs. The reduction in efficiency found for 2005 was due to implementation of new regulations on debt classification and loan-loss provisioning that forced banks to increase their non-interest cost. Implementation of this

regulation is likely to have contributed to a structural break in the data after 2005, and hence data homogeneity is questionable.

Vu and Turnell (2012) provided a parametric measure of productivity change using a hyperbolic distance function with the same data sample as Vu and Turnell (2010). The results showed that the Vietnamese banking industry experienced modest productivity growth due to technological progress. Moreover, FBs achieved the highest productivity growth because they possessed advanced technology infrastructure and operated at an appropriate scale.

Nalm and Vu (2013) reused the sample data of Vu and Turnell (2010) to estimate the efficiency and productivity of Vietnamese banks. Based on a directional distance function the authors measured profit efficiency and its components of technical and allocative efficiency. A generalised Malmquist productivity index was also derived and decomposed into pure technical efficiency change, scale efficiency change and technological change. The findings are: (1) in terms of profit efficiency average banks operated quite far below the frontier of the best practice banks mainly due to allocative inefficiency rather than technical inefficiency; (2) price efficiency and profit efficiency scores of SOCBs were much higher than JSBs and FBs due to their market power in setting prices; (3) during 2000−2006 the banking industry achieved modest productivity growth due to technological progress. The reused data still faced the limitation of data heterogeneity as mentioned above.

Generally, pre-WTO entry studies on banking efficiency in Vietnam provided conflicting results on the trend of efficiency. This is possibly because the bank samples were different, and the data was not homogenous. Except for the study conducted by Vu

and Turnell (2010), the others totally ignored the effects of the restructuring plan on the efficiency of banks. Moreover, technological progress should be analysed in depth because the period 2000−2006 experienced a substantial change in banking operations when all banks applied the core banking system based on the internet, inter-bank payment system, and the Automatic Teller Machine (ATM) system.

The post-WTO accession period witnessed a number of policies aimed at improving the efficiency of domestic banks under the threat from foreign bank penetration. The policies included: (1) equitising SOCBs; (2) permitting foreign financial institutions to have capital participation in domestic banks; (3) transforming 13 rural to urban banks and granting new bank licenses; (4) allowing SOEs and private business groups to engage in the banking sector. These policies are likely to have influenced banking efficiency and are necessary to be analysed in depth. Moreover, the booming property market, which essentially depended on banking credit, can be expected to have strongly exerted an effect on banking efficiency. Although a lot of important changes occurred after Vietnam joined the WTO a limited number of studies have been conducted to investigate their impact on banking efficiency.

Dang-Thanh (2010) used a basic DEA model to measure the efficiency scores of banks in Vietnam using a sample of 22 banks in 2008. The results suggested that the mean technical efficiency scores under the variable returns to scale (VRS) assumption or constant returns to scale (CRS) assumption are close to one. However, this finding is not reliable because it is based on banking performance in only one year (2008). Additionally, this research does not mention the possible influences of policy changes in the post-WTO entry period.

Nguyen (2012) employed a similar DEA method to measure the efficiency and productivity of Vietnamese banks during the period 2007−2010 using a sample of 20 banks. The author found that the efficiency scores continuously increased from 2007−2010. Mean technical efficiency in 2008 was found to be 0.686 which is very different compared with that obtained by Ngo (2010). The difference can be explained by the different sample, and by the different sources of data. In addition, the technical efficiency scores of SOCBs are significantly lower than that of JSBs. Given there are many major policy changes during this period, those studies however did not consider these changes. Ngo (2012) conducted another study using macro data to analyse the relationship between DEA-based banking efficiency and liberalisation from 1990−2010. To measure liberalisation in the banking sector a KAOPEN index developed by Chinn and Ito (2008) was used. However, the results obtained did not support his hypothesis that financial liberalisation positively impacted banking efficiency in Vietnam. Homogeneity of the data is doubtful due to significant changes in accounting standards and national statistical practices during the research period.

There have been nine studies in total on Vietnamese banking efficiency to date (see Table 3.3). Most of these studies have focused on measuring and analysing the technical efficiency and productivity of the banking sector in the pre-WTO accession period (2000−2006)[45]. There are a number of studies measuring technical efficiency in the post-WTO; however changes in policies as well as from the business environment influencing the banking sector have not been mentioned and analysed. This study is the first to evaluate the technical efficiency of Vietnam's commercial banks covering the period 2005−2012, which incorporates both the pre- and post-WTO period. In addition,

[45] Vietnam officially became the 150th member of the WTO from January 2007.

it is the first study to test for a linkage between banking sector related policy changes and banking efficiency.

The Vietnamese economy in general and its banking sector in particular are in a transition process from a planned to a complete market economy. Consequently, the characteristics of the banking sector[46] in a transition economy have to be accounted for in analysing efficiency. Nonetheless, previous research has not adequately addressed or only slightly considered these characteristics. As a result the roots of the underperformance in the banking sector are largely ignored when analysing banking efficiency and productivity.

According to Simar and Wilson (1998), efficient firms are inadequately included in the sample and so DEA estimates can be biased. These previous studies, however, do not address these issues; therefore it is likely that their estimates may suffer from these problems. Moreover, all regressions of technical efficiency scores on the determinants are inconsistent due to a serial correlation defect of the dependent variable (Xue and Hacker, 1999). Obviously, the results attained are not reliable and a better method that overcomes these restrictions should be discovered and applied in such studies. In this context, this study addresses such issues to produce unbiased and more accurate results.

Due to the issuance of new accounting standards in 2005, all studies using before-2005 data need to be adjusted to fit new accounting standards due to the fact that the loan-loss provisioning cost which takes up a substantial part of total cost was excluded before 2005. Consequently, studies using data from 2005 are much more consistent and accurate.

[46] These characteristics are referred to in Section 3.4.1.

To the author's knowledge, in the relevant literature, there have been studies on the impact of WTO accession on banking efficiency but only for the case of China – another transition country in Asia (Yao *et al*., 2007; Berger *et al*., 2009; Jiang *et al*., 2009). China and Vietnam together conducted a similar gradualist approach to banking sector transition. Before joining the WTO their banking sectors were relatively closed to foreign investors. In contrast, transition countries in Europe conducted a "big-bang" approach; and most of them definitively liberalised their banking sectors at an early stage of their transition so that the impact of their subsequent WTO accession was insignificant. Studies on banking efficiency in Vietnam in the post-WTO accession in comparison with that of China are important to discover the common characteristics of the banking sectors in these gradualist transition countries.

3.6 Summary

This chapter has reviewed several important aspects relating to bank efficiency in the literature, including a summary of methods that have been used for estimating efficiency, and regression techniques for regressing efficiency scores on environmental variables. Financial liberalisation and its impact on banking efficiency has been analysed in both a single-country and cross-country framework. Additionally, a review of the transformation process in transition countries from a government dominated banking sector to a foreign controlled one has also been highlighted. Lastly, previous studies on Vietnamese banking efficiency have also been summarised so as to identify the limitations, weaknesses as well as the research gap to be filled by this thesis.

In the following chapter, conceptual framework on efficiency and methods used to estimate and analyse technical efficiency scores will be presented. Specifically,

bootstrap techniques are employed as the unique solution to overcome biased and dependent nature of DEA-estimated efficiency scores.

Table 3.1: A Summary of Financial Liberalisation and Deregulation Impacts on Bank Efficiency

Publications	Countries or Regions	Type of countries	Period	Method - Approach	Input Variables	Output Variables	Environmental Variables	Bank specific variables	Financial Liberalisation Aspects	Findings
Havrylchyk (2006)	Poland	Transition	1997 - 2001	DEA – Intermediation	Deposits Fixed assets Labour	Loans Treasury bonds Off-balance items	Dummy variables differ domestic-foreign ownership	Growth of assets Capitalisation Loans/total asset Total assets	Foreign bank entry	Foreign banks exhibit higher efficiency due to greenfield banks rather than takeover banks.
Hermes & Vu (2010)	Latin America and Asia	Developing & Emerging	1991 - 2000	DEA – n.a	n.a	n.a	Density of demand GDP growth Inflation rate	CAR ROE Total loan/deposits	Interest rates Entry barriers Reserve requirement Credit controls Privatization Prudential regulation	Positive impact of financial liberalization on bank efficiency
Ataullah*et al*. (2004)	India and Pakistan	Developing & Emerging	1988 - 1998	DEA – Intermediation Operating	Operating expenses Interest expenses Operating expenses Interest expenses	Loans and advances Investment Interest income Non-interest income	NPLs	Bank size	Interest rates Credit policies Reserve requirement Entry of private sector Public banks	Financial liberalization improves bank efficiency. The gap of efficiency scores between two approaches due to NPLs.

Publications	Countries or Regions	Type of countries	Period	Method - Approach	Input Variables	Output Variables	Environmental Variables	Bank specific variables	Financial Liberalisation Aspects	Findings
									privatisation	
Casu&Molyneux (2003)	Specific EU members: France, Germany, Italy, Spain, UK	Developed	1993 – 1997	DEA - Intermediation	Total cost Total deposits	Loans Other earning assets	Country specific variables	E/A ratio ROEA Commercial banks or not Listed or not in stock exchange	Merging banking markets of EU members through SMP (Single Market Program) conducted from 1993	Slightly improved efficiency. The gap of efficiency amongst countries is due to country specific characters such as management strategies and informatics technology.
Das *et al.* (2005)	India	Emerging	1997 - 2003	DEA – Intermediation	Borrowed funds No. of employees Fixed assets Equity	Investment NPLs Fee-based incomes		Bank size Ownership structure List or not in stock exchange	Interest rates Market entry Reserve requirement	Profit efficiency improved. Positive impacts of asset size, ownership, being listed in stock market on efficiency.
Williams & Nguyen (2005)	South East Asia	Developing	1990 - 2003	SFA - Intermediation	Interest Personnel expenses	Loans Other earning assets Non-interest income	Dynamic governance indicators Selection governance indicators	Exit variables Static governance indicators Bank assets	Bank privatization Widening access to foreign institutions	Bank privatization raised bank performance. Foreign acquisition did not result in better performance.
Hasan&Marton (2003)	Hungary	Developed	1993 - 1998	SFA – Intermediation	Borrowed fund Labour and related expenses	Loans Investment Fee income Interest	Acquisition	A set of financial ratios (e.g: E/A, L/A) Assets Age Percentage of	Bank privatization Foreign bank entry and involvement with domestic banks	Profit and cost efficiency improved. Banks with foreign involvement were less inefficient. Higher share of foreign ownership is associated with lower inefficiency.

Publications	Countries or Regions	Type of countries	Period	Method - Approach	Input Variables	Output Variables	Environmental Variables	Bank specific variables	Financial Liberalisation Aspects	Findings
								assets owned by foreign investors		
Yao *et al.* (2008)	China	Emerging	1998 - 2005	DEA – Operating	Interest expenses Non-interest expenses	Interest income Non-interest income		Bank size Ownership	Bank privatization Removing restrictions on foreign investments	SOCBs achieved high technical efficiency. Total factor productivity of SOCBs increased due to technical efficiency when it was technical progress for JSBs.
Das &Ghosh (2006)	India	Emerging	1992 - 2002	DEA – Intermediation Value-added Operating	Demand, Saving, Fixed deposits Capital-related operating cost Labour cost Capital-related operating cost Labour cost Interest expenses Capital-related operating cost Labour cost	Advances Investments Advances Investments Interest income Non-interest income		Bank size Ownership CAR NPLs Management quality	Liberal entry of foreign banks Allowing functioning of new private banks Public banks privatization Dismantle of interest rate regime	Banks with higher CAR were more efficient. Higher technical efficiency banks were associated with lower NPLs. Competitive changes positively impacted small and medium banks or banks with lower manpower deployment and high technology intensity.

Publications	Countries or Regions	Type of countries	Period	Method - Approach	Input Variables	Output Variables	Environmental Variables	Bank specific variables	Financial Liberalisation Aspects	Findings
Drake *et al.* (2006)	Hong Kong	Developed	1995 – 2001	DEA – Operating	Employees expenses Non-interest expenses Loan-loss provisions	Net-interest income Net commission income Other income	External shocks (EAFC, accession to the PRC, 2001 terrorist event)	N/A	Removal of interest rate cap	Efficiency was impacted by external factors. Strong size-efficiency relationship.
Sturm & Williams (2004)	Australia	Developed	1988 - 2001	DEA, SFA – Intermediation Operating	No. of employees Deposits Equity Interest expenses Non-interest expenses	Advances Off-balance items Interest income Non-interest income	N/A	Ownership Bank types	Remove restrictions on foreign entry	Scale efficiency dominated technical efficiency. Bank productivity improved. The main source of productivity gain was technological progress. Foreign banks experienced superior scale efficiency. Diversity of bank types was a main source for competition and efficiency
Hao*et al.* (2001)	Korea	Developed	1985 - 1995	SFA - Intermediation	Labour cost Physical capital expense Interest expense	Loans & securities Demand deposits Fee income	Reform	Age Bank asset Growth rate Salary-asset ratio Branches-deposit ratio Employee-asset ratio	Reprivatisation Removal of interest rate ceilings and entry restrictions Reduction of government directed lending Expanded product deregulation Reduction of restrictions on	More efficient banks with faster growth rates, nationwide operating, extensive use of core deposits, more capital-intensified, higher foreign equity ownership. Less efficient banks with higher level of long-term private sector debt, and the level of real goods, exports.

Publications	Countries or Regions	Type of countries	Period	Method - Approach	Input Variables	Output Variables	Environmental Variables	Bank specific variables	Financial Liberalisation Aspects	Findings
								Demand deposit-total deposit ratio	foreign exchange transactions.	
Denizer*et al.* (2007)	Turkey	Developing	1970 – 1994	DEA – Production Intermediation	Own resources Operational expenses Interest and fee Own resources Operational expenses Deposits	Deposits Non-interest income Loans Banking income	Inflation rate Growth rate	Ownership	N/A	Average technical efficiency followed a downward trend. The state owned banks performed better than private and foreign banks. Inflation and economic growth negatively impacted on efficiency.
Chortateas *et al.* (2013)	27 European countries	Developed	2001 - 2009	DEA – intermediation	Personnel expenses Fixed assets Interest expenses	Loans Other earning assets	Economic freedom variables Institutional variables	Equity/asset ratio ROAE Total assets Loans/asset ratio	N/A	Positive relationship between economic freedom/institutional governance and banking efficiency.
Grifell-Tatje& Lovell (1996)	Spain	Developed	1986 - 1991	DEA – production	No. of employees Expenditure on material Expenditure on building plus depreciation	No. of loan acc. No. of checking acc. No. of saving acc.	M&A	Loan/deposit ratio	Free interest rate and fee Branching outside banks' geographic region Lower reserve requirement	A decline of productivity Fast-branching banks had lower productivity No productivity gain following M&A Efficient banks with higher loan/deposit ratio

Publications	Countries or Regions	Type of countries	Period	Method - Approach	Input Variables	Output Variables	Environmental Variables	Bank specific variables	Financial Liberalisation Aspects	Findings
						No. of branches			Phasing out investment requirement	
Jiang *et al.* (2009)	China	Emerging	1995 - 2005	SFA – intermediation operating	Model 1: interest expense; non-interest expense Model 2: interest expense; labour and physical capital Model 3: interest expense; physical capital; labour	interest income; non-interest income loans; deposits; non-interest income loans, deposits; other earning assets	Time trend GDP growth rate Foreign acquisition	Static effect indicator E/A LLD/Loan Interbank fund/deposit Loans/Deposit	Foreign acquisition SOCBs privatization	JSBs are the most efficient and next to SOCBs while FBs are the least IPOs and foreign acquisition of SOCBs are affective to improve efficiency of banks.
Berger *et al.* (2009)	China	Emerging	1994 – 2003	SFA – intermediation	Interest expense Physical inputs	Loans Deposits Liquid assets Other earning assets		Ownership Bank size	Foreign bank entry Minority foreign ownership	SOCBs are the least efficient and the FBs are the most. Minority foreign ownership increased bank efficiency.

Publications	Countries or Regions	Type of countries	Period	Method - Approach	Input Variables	Output Variables	Environmental Variables	Bank specific variables	Financial Liberalisation Aspects	Findings
Kumbhakar& Wang (2007)	China	Emerging	1993 - 2002	SFA – intermediation	Labour Fixed assets Deposits plus borrowed funds	Loans net Other earning assets	Deregulation	E/A Ownership Bank size	Interest deregulation Elimination of local government intervention on SOCBs lending New bank entry	Joint-equity banks achieved higher efficiency than SOCBs Larger banks were less efficient Modest improvement of banking productivity
Chen *et al*. (2005)	China	Emerging	1993 - 2000	DEA - intermediation	Interest expense Non-interest expense	Loans Deposits Non-interest income	Deregulation	Ownership Bank size	Interest deregulation Elimination of local government intervention on SOCBs lending New bank entry	Efficiency improved in the early deregulated period Larger and small banks were more efficient
Park & Weber (2006)	Korea	Developed	1992 - 2002	DEA – intermediation Operating	Labour Physical capital Deposits Interest expense Non-interest expense	Loans Securities Demand deposits NPLs Non-interest income Interest income Fee income			Interest rate deregulation Policy loans elimination Foreign transaction deregulation Bank ownership restructuring	More inefficient banks Productivity growth due to technical progress offsetting efficiency decline.

Publications	Countries or Regions	Type of countries	Period	Method - Approach	Input Variables	Output Variables	Environmental Variables	Bank specific variables	Financial Liberalisation Aspects	Findings
Maudos*et al.* (2002)	Spain	Developed	1985 - 1996	DEA – intermediation	Labour Physical capital Deposits	Loanable funds Loaned funds		Bank size Bank type Quality of input Time trend	Banking specification	The efficiency improved Positive relationship between cost efficiency and bank size; and personnel qualification; Foreign bank reached highest efficiency level
Kraft *et al.* (2006)	Croatia	Transition	1994 - 2000	SFA – intermediation	Fixed capital Labour Interest expense	Loans to enterprises Loans to customers Deposits		Bank size Ownership Age	Bank privatisation Foreign entry	Foreign banks were the most efficient while the private banks were the least Insignificant impacts of privatisation

Source: Compiled and summarised by the author

Table 3.2: A Summary of Financial Liberalisation and Deregulation Impacts on Bank Efficiency in Transition Economies

Publications	Countries or Regions	Period	Method - Approach	Input Variables	Output Variables	Environmental Variables	Bank specific variables	Bank restructuring measures	Findings
Fang *et al*. (2011)	6 Countries in South Eastern Europe	1998 – 2008	SFA – Intermediation	Borrowed funds Fixed assets	Loans Securities Other earning assets	Country-specific variables	Equity NPLs	Privatisation Foreign entry Enterprises reform	Foreign owned banks were less cost efficient but more profit efficient Profit efficiency of foreign banks declined over time Government owned banks became more efficient in the later years of transition.
Kara*set al*. (2010)	Russia	2002 and 2006	SFA – production Intermediation	Physical capital Labour Deposits Physical capital Labour	Total deposit Loans Loans Securities	Regional variables	Equity Risk-preference ratios	Privatisation Foreign entry	Foreign banks were more efficient than domestic banks Domestic private banks are less efficient than the public banks Adopting deposit insurance is only effective in improving bank efficiency for the case of lowly transparent regulation.
Yildirim&Philoppatos (2007)	12 countries Central and Eastern Europe	1993 – 2000	SFA – DFA	Borrowed funds Labour Physical capital	Loans Investments Deposits	GDP rate Listed Concentration	Bank size Risk preference variables Foreign owned	Foreign entry	Higher efficiency level was associated with large and well-capitalised banks. Lower efficiency resulted from bad loans Competition made lower cost and higher profit efficiency. Market concentration is negatively linked to profit efficiency Foreign banks were more cost efficient but less profit efficient
Kasman&Yildirim(2006)	8 countries central and eastern	1995 – 2002	SFA – Value Added	Labour Physical capital	Loans Other earning	Density of population Income per	Average capital ratio Intermediation		Foreign banks perform better than domestic banks in terms of cost and profit efficiency.

Publications	Countries or Regions	Period	Method - Approach	Input Variables	Output Variables	Environmental Variables	Bank specific variables	Bank restructuring measures	Findings
	Europe			Purchased funds	assets Total deposits	capita Density of demand GDP rate M2/GDP Inflation	ratio Concentration ratio		
Bonin *et al*. (2005a)	11 European countries	1996 – 2000	SFA – intermediation	Capital Purchased funds	Total deposits Liquid assets Total loans investments		Bank size Ownership Year Countries ROA	Foreign involvement	Foreign ownership had a positive effect on bank efficiency Government-owned banks were less efficient than domestic private banks
Bonin *et al*. (2005b)	6 European countries	1994 – 2002	SFA – intermediation		Total deposits Total loans Total liquid assets Investments	Bank privatisation Foreign bank entry	Bank ownership	Domestic and foreign sector involvement	Government-owned banks were the least efficient and foreign greenfield banks were the most. The positive impact of a strategic foreign investor Voucher-privatised banks were less efficient than domestic banks and banks privatised by other methods.
Fries *et al*. (2006)	15 countries in Eastern Europe	1995 – 2004	Margins, marginal cost and market-ups					Privatization Foreign bank entry	Privatization of state-owned banks linked with greater demand for lending and deposit taking. Higher mark-ups in domestic banks than state-owned banks Foreign banks had lower marginal costs

Publications	Countries or Regions	Period	Method - Approach	Input Variables	Output Variables	Environmental Variables	Bank specific variables	Bank restructuring measures	Findings
Poghosyan &Poghosyan (2010)	11 countries	1992 – 2006	SFA – Intermediation	Labour Capital Borrowed funds	Total earning assets			Foreign bank entry	Foreign greenfield banks expressed the most operational efficiency. The performance of foreign-acquired banks exhibited an offsetting dynamic pattern.
Grirorian& Manole (2006)	17 countries	1995 - 1998	DEA	Labour Fixed assets Interest expenses	Revenue Net loans Liquidassets	Macroeconomic variables Regulatory variables Institutional/legal Development of capital market	Equity/Assets Market concentration Bank age Foreign ownership Capital adequacy		Large and well-capitalised banks were more efficient Foreign banks were more efficient
Weill (2007)	11 Western countries and 6 Eastern and Central European countries	1996 – 2000	SFA -	Personnel expenses Other non-interest expenses Interest paid	Loans Investment assets	Per capita income Rate of inflation Population density Density of demand Intermediation ratio			Existence of an efficiency gap between Western and CEE banks. A convergence of efficiency in CEE banks towards Western banks.

Publications	Countries or Regions	Period	Method - Approach	Input Variables	Output Variables	Environmental Variables	Bank specific variables	Bank restructuring measures	Findings
						Banking competition			
Fries &Taci (2005)	15 countries	1994 - 2001	SFA – Intermediation	Labour Physical capital	Loans Deposits	GDP per capita Nominal interest rate Density of demand Share of majority foreign owned banks in total asset L/D E/A Index of banking reform	NPL rate Ratio of non-loan assets/total assets Bank origin and ownership		Country-level factors including a greater market share of majority foreign owned banks, lower nominal interest, and a higher intermediation ratio increased cost efficiency. Private banks were more cost efficient than state owned banks. Among private banks, privatized banks with majority foreign ownership were the most cost efficient.
Kraft *et al.* (2006)	Croatia	1994 – 2000	SFA – intermediation	Fixed capital Labour Interest expense	Loans to enterprises Loans to customers Deposits		Bank size Ownership Age	Bank privatisation Foreign entry	Foreign banks were the most efficient while the private banks were the least efficient Insignificant impacts of privatisation
Jiang *et al.*	China		SFA – intermediation	Model 1: interest expense; non-	Interest income; non-	Time trend GDP growth	Static effect indicator	Foreign acquisition	JSBs are the most efficient and next to SOCBs while FBs are the least efficient

Publications	Countries or Regions	Period	Method - Approach	Input Variables	Output Variables	Environmental Variables	Bank specific variables	Bank restructuring measures	Findings
(2009)			Operating	interest expense Model 2: interest expense; labour and physical capital Model 3: interest expense; physical capital; labour	interest income Loans; deposits; non-interest income Loans, deposits; other earning assets	rate Foreign acquisition	E/A LLD/Loan Interbank fund/deposit Loans/Deposit	SOCBs privatization	IPOs and foreign acquisition of SOCBs are effective to improve bank efficiency.
Berger *et al.* (2009)	China	1994 - 2003	SFA – intermediation	Interest expense Physical inputs	Loans Deposits Liquid assets Other earning assets		Ownership Bank size	Foreign bank entry Minority foreign ownership	SOCBs are the least efficient and the FBs are the most efficient. Minority foreign ownership increased bank efficiency.
Kumbhakar & Wang (2007)	China	1993 - 2002	SFA – intermediation	Labour Fixed assets Deposits plus borrowed funds	Loans net Other earning assets	Deregulation	E/A Ownership Bank size	Interest deregulation Elimination of local government intervention on SOCBs lending New bank entry	Joint-equity banks achieved higher efficiency than SOCBs Larger banks were less efficient Modest improvement of banking productivity

Publications	Countries or Regions	Period	Method - Approach	Input Variables	Output Variables	Environmental Variables	Bank specific variables	Bank restructuring measures	Findings
Chen *et al*. (2005)	China	1993 - 2000	DEA - intermediation	Interest expense Non-interest expense	Loans Deposits Non-interest income	Deregulation	Ownership Bank size	Interest deregulation Elimination of local government intervention on SOCBs lending New bank entry	Efficiency improved in the early deregulated period Larger and small banks were more efficient
Hasan&Marton (2003)	Hungary	1993 – 1998	SFA – Intermediation	Borrowed funds Labour and related expenses	Loans Investment Fee income Interest	Acquisition	A set of financial ratios (e.g: E/A, L/A) Assets Age Percentage of asset owned by foreign investors	Bank privatization Foreign bank entry and involvement with domestic banks	Profit and cost efficiency improved. Banks with foreign involvement were less inefficient. Higher share of foreign ownership is associated with lower inefficiency.
Havrylchyk (2006)	Poland	1997 - 2001	DEA – Intermediation	Deposits Fixed assets Labour	Loans Treasury bonds Off-balance sheet items	Dummy variables differ domestic-foreign ownership	Growth of assets Capitalisation Loans/total asset Total assets	Foreign bank entry	Foreign banks exhibit higher efficiency due to the greenfield banks rather than takeover banks.

Source: Compiled and summarised by the author

Table 3.3: A Summary of Studies on the Efficiency and Productivity of the Vietnamese Banking Sector

Publications or Unpublished papers	Efficiency Analysis	Productivity Changes	Assumption	Statistical Inferences	No of firms	Sample Period	Input Variables	Output Variables	Environment Variables	Findings
Nguyen. VH (2007)	DEA	Malmquist	VRS	No	13	2001-2003	Labour Fixed assets Deposits	Interest income Non-interest income	N/A	Average technical efficiency score is low and the sources of inefficiency are derived from both allocative and technical problems. The productivity Malmquist index slightly decreased
Nguyen. XQ (2008)	Bootstrapped DEA (Atkinson & Wilson, 1995)	Malmquist	CRS	No	15	2003-2006	Labour Assets Deposits Operating cost	Loans and advances Investment	N/A	The technical efficiency scores were very high. The state-owned banks are found to be more efficient than private banks.
Nguyen *et al*, (2013)	SMB with super-efficiency DEA (Output orientation)	N/A	VRS	Yes (Tobit model)	32	2001-2005	Received interest Other operating income	Personal expense Net total assets	Ownership Bank size Labour Quality	State ownership negatively affected efficiency. A positive relationship between efficiency and bank size, market share were also found. The technical efficiency scores increased.
Vu &Turnell (2010)	SFA (Bayesian estimation)	N/A	VRS	Yes	54	2000-2006	Labour, Fixed assets and Deposits plus balances with other banks	Customer loans Other assets Off-balance sheet assets	N/A	Cost efficiency mostly unchanged and SOCBs reached higher efficiency than private banks.

Publications or Unpublished papers	Efficiency Analysis	Productivity Changes	Assumption	Statistical Inferences	No of firms	Sample Period	Input Variables	Output Variables	Environment Variables	Findings
Vu &Turnell (2012)	Hyperbolic SFA (Bayesian estimation)	Malmquist	VRS	Yes	54	2000-2006	Customer loans Other earning assets Off balance sheet items	No. of full-time employees Fixed assets Deposits plus borrowed funds	N/A	Banks experienced modest productivity growth. FBs achieved highest productivity growth.
Nalm&Vu (2012)	DEA with directional distance function (output orientation)	Malmquist	VRS	No	54	2000-2006	Customer loans Other earning assets Off balance sheet items	No. of full-time employees Fixed assets Deposits plus borrowed funds	N/A	Average banks operated quite far below the frontier. Price and profit efficiency scores of SOCBs were highest. Banking industry achieved modest productivity growth due to technological progress.
Ngo (2010)	DEA (input orientation)	N/A	VRS	No	22	2008	Wage, Interest expense, Other expense	Total assets, Interest income, Other income	N/A	Technical efficiency scores are close to optimal efficiency.
Nguyen. HV (2012)	DEA	Malmquist	VRS	No	20	2007-2010	Labour expenses Fixed assets Saving deposits	Interest income Non-interest income	N/A	The efficiency scores continuously increased. Technical efficiency scores of SOCBs are significantly lower than that of JSBs.
Ngo (2012)	Two stage DEA	N/A	VRS	Yes (Tobit model)	N/A	1990-2010 (macro data)	Deposits	Credits Gross domestic capital Liquidities	KAOPEN CRISIS	Negative relationship between banking efficiency and liberalisation.

Source: Compiled and summarised by the author

Chapter 4: Methodology

4.1 Introduction

The objective of this thesis is to investigate the performance of Vietnamese commercial banks and identify possible impacts of the country's entry into the WTO on bank performance. Hence, it is important to identify reliable measures of bank performance aimed at identifying which banks or bank groups have performed better than others. In the literature on banking operations two methods have been used to quantify bank performance: the financial ratio method and the production frontier method (Das and Ghosh, 2006; Hughes and Mester, 2008). The financial ratio method is based on financial profitability using indexes such as return on assets (ROA), return on equity (ROE) and net interest margin (NIM) to measure the extent to which output (as measured by profit, revenue and cost) is generated from one unit of input (as measured by total assets, number of employees and deposits). However, this method has a number of disadvantages:

(1) it is strongly influenced by accounting practices within each bank[47]; and

(2) it is a unilateral measure because only one input and one output variable are considered for each ratio.

Moreover, using different financial ratios to compare the performance of different banks may bring about conflicting results. For example, bank A may be better than bank B when using ROA but the result could be reversed in the case of NIM. Consequently, the

[47] The frontier-based method is less influenced by accounting practices within individual banks because this method is based on accounting data for the whole banking system (Hughes and Mester, 2008).

production frontier method, which employs many inputs and many outputs to measure bank performance, is preferable and is the approach used in this study.

There are two methods widely used to estimate production frontiers: stochastic frontier analysis (SFA) and data envelopment analysis (DEA) (Kenjegalieva *et al.*, 2009; Fethi and Pasiouras, 2010). The SFA approach assumes a given form of the production function showing the relationship between inputs and output before estimation of the parameters is conducted (Coelli *et al.*, 2005; Kumbhakar and Wang, 2007). Then the estimated production functions are used to measure the efficiency scores of firms. The other method, DEA, which is based on linear programming, is used in the literature to build a piecewise production frontier that acts as a benchmark for measuring relative efficiency. In this thesis, DEA is employed mainly because this method can be utilised with a small sample size and allows for multiple outputs while only one output is allowed in SFA models[48] (Coelli *et al.*, 2005). In the banking sector, banks provide numerous services to customers and generate many outputs and therefore DEA can be seen to be the more suitable method.

Vietnam is an interesting case study as it is one of the few transition economies where the banking sector is still dominated by state-owned commercial banks (SOCBs). In contrast, transforming to a competitive and privately-controlled banking sector has been implemented in most other transition countries (Bonin and Schnabel, 2011). This difference in approaches to reform financial sectors can be explained by the different policies adopted. If governments conduct consistent reform measures to construct a

[48]Due to the fact that SFA is based on regression techniques and so only one output can be employed as the dependent variable while a set of inputs play the role of independent variables. This issue can be solved by using specific statistical techniques, for example, Ruggiero (1998) utilised canonical correlation analysis to measure technical efficiency for multi output production correspondences.

competitive and fair[49] business environment for banks, private banks with profit-based incentives can be expected to perform better than their publicly owned counterparts and play a more substantial role in the banking sector. By contrast, governments desiring to maintain control and exert influence over the banking sector for political purposes would implement supportive measures for SOCBs and discriminate against domestic and foreign private banks (Karas *et al.*, 2010; Vernikov, 2012). The consequence of this is that a level and homogenous business environment for SOCB and private bank groups is not present. It is, therefore, necessary to take the heterogeneity of the business environment into account when measuring and analysing bank performance, and this is obviously required in the case of Vietnam. Thus, in this study, a meta-frontier analysis, as proposed by Battese and Rao (2002), Battese *et al.* (2004) and O'Donnell *et al.* (2008) is adopted which is a production frontier approach that can separate bank groups by ownership to measure their efficiency and allow environmental variables to be regressed against each group's efficiency.

Using a meta-frontier approach is more advantageous than using a conventional single frontier approach. This is due to the fact that the latter sees all firms as having the same technology set and that they are homogeneous across different groups. However, this is not the case in the context of Vietnam where the business environment is heterogeneous due to the discriminatory policies implemented by the state. Furthermore, only a meta-frontier approach can examine which group of firms is technically more advanced relative to the others via utilising the so-called technology gap ratio criteria.

The rest of this chapter is structured as follows: Section 4.2 provides a definition of, and conditions necessary to use, a meta-frontier analysis approach; Section 4.3 explains how

[49] The term "fair" as used here refers to "non-discrimination" between different bank ownership types.

the DEA efficiency scores of individual firms (banks) and firm (bank) groups used in this study are estimated and regressed against a set of explanatory variables. In addition, the bootstrap-based method is introduced in this section as a good tool to overcome the biased nature of DEA estimates as highlighted in Chapter 3; Section 4.4 introduces the Li (1996) test which will be used to investigate the equality of efficiency distributions; Section 4.5 presents a measure of total factor productivity, the so-called Aggregate Malmquist Productivity Index (AMPI), which is constructed based on an extension of the concept of aggregate technical efficiency; and finally, Section 4.6 summarises the key findings from this chapter.

4.2 A proposed methodology – Meta-frontier analysis

O'Donnell *et al*. (2008) states that "firms in different industries, regions and/or countries face different production opportunities. Technically, they make choices from different sets of feasible input–output combinations. These so-called technology sets differ because of differences in available stocks of physical, human and financial capital (e.g., type of machinery, size and quality of the labour force, access to foreign exchange), economic infrastructure (e.g., number of ports, access to markets), resource endowments (e.g., quality of soils, climate, energy resources) and any other characteristics of the physical, social and economic environment in which production takes place." The authors highlight the impact of the operating environment on firm efficiency and conclude that "such differences have led efficiency researchers to estimate separate production frontiers for different groups of firms" (O'Donnell *et al*., 2008, p.231-232).

The efficiency of firms within such groups can be measured by comparing them to the best practice performance firms which construct each group's frontier. Nonetheless, there is still a question of how best to measure the relative efficiency of firms across groups. Based on the concept of a meta-production function[50], a meta-frontier is estimated by enveloping all group frontiers. Thus, the technical efficiency of firms belonging to different groups can be compared by using the distances of these firms from the meta-frontier.

As mentioned in Section 4.1, Vietnamese banks that have different ownership forms operate in different business environments due to discriminatory government policies. The discriminatory policies applied to particular bank groups can result in differences of production technology as the mechanism producing outputs from relevant inputs (O'Donnell *et al*., 2008). For example, under given inputs such as labour and fixed assets, public banks can attract more saving deposits than their private counterparts because the former is believed to be more credible due to the guarantee of solvency by the state. Hence, a meta-frontier analysis that allows for different technology sets in measuring the efficiency of different groups is employed in this thesis to measure and analyse bank performance in and across different bank ownership groups.

4.2.1 The meta-frontier

In general terms, this research considers an industry consisting of n firms. Each firm employs p inputs to produce q outputs. Let $x \in \mathbb{R}_+^p$ denote a (1×p) vector of inputs and

[50]Hayami and Ruttan (1970) conceptualised the meta-production function as the envelope of commonly conceived neoclassical production functions.

$y \in \mathbb{R}_+^q$ denote a (1×q) vector of outputs. Under a given technology, following O'Donnell *et al.* (2008) the production set of the industry can be defined by:

$$\wp = \{(x, y) \in \mathbb{R}_+^p \times \mathbb{R}_+^q : x \; can \; produce \; y\} \qquad (4.1)$$

The production set is built using two components: boundary and interior. The production boundary (or meta-frontier) is identified by the best practice firms or efficient firms. It is convenient to represent technology using the output-oriented[51] distance function and the technical efficiency of firm *k* as being equal to:

$$D_o^k(x^k, y^k) = inf\{\theta^k : (x^k, y^k/\theta^k) \in \wp\} \; (\theta^k \leq 1) \quad (4.2)$$

If the value of the distance function is equal to unity ($D_o^k(x^k, y^k) = 1$), firms are located on the boundary and considered technically efficient. If the value is not equal to unity they are inside the production interior ($D_o^k(x^k, y^k) < 1$) and are relatively inefficient.

4.2.2 Group frontiers

The industry can be classified into L groups operating under L different group-specific technologies. These sub-technologies can be characterised by the following group-specific production sets and group output distance functions:

$$\wp^g = \{(x, y) \in \mathbb{R}_+^p \times \mathbb{R}_+^q : x \; can \; be \; used \; by \; firms \; in \; group \; g \; to \; produce \; y, g = 1, \dots, L\} \qquad (4.3)$$

[51] Whether to use the input or output orientation depends on a firm's objectives (Coelli *et al*., 2005). In the context of the Vietnamese banking sector in the post-WTO period, banks rapidly expanded their services and customer base under the expansionary monetary policy of the SBV to stimulate economic growth (Pincus, 2009; WB, 2009; WB, 2012). Banks focused on maximising their outputs (loans) rather than minimising inputs (which are labour and fixed assets). Thus, in this thesis, output-oriented models are adopted.

and

$$D_o^{G,k}(x^k, y^k) = inf\{\theta^k : (x^k, y^k/\theta^k) \in \wp^g\} \qquad (4.4)$$

The boundaries of the group-specific production sets are referred to as group frontiers. The meta-production set of the industry envelops all L group production sets $\wp \equiv \wp^1 \cup \wp^2 \ldots \cup \wp^L$ and the group-specific production sets are subsets of the unrestricted meta-production set.

In this thesis, according to ownership, there are three group-specific frontiers belonging to state-owned banks, private and foreign banks.

4.2.3 Meta-technology ratios

The gap between the group frontier and the meta-frontier (the technology gap) at a particular input/output combination ($x^k,\ y^k$) can be identified by the meta-technology ratio (MTR):

$$MTR(x^k,\ y^k) = \frac{D_o^k(x^k, y^k)}{D_o^{G,k}(x^k, y^k)} \qquad (4.5)$$

where$D_o^{G,k}(x^k, y^k)$ and $D_o^k(x^k, y^k)$are distance functions identified as the distances to the group frontier and the meta-frontier respectively.

The MTR of the group is identified to measure how close the group frontier is to the meta-frontier by averaging all individual MTRs of firms within each group.

Equation 4.5 is also equivalent to:

$$D_o^k(x^k, y^k) = D_o^{G,k}(x^k, y^k) \times MTR(x^k, y^k) \qquad (4.6)$$

Equation 4.6 can be explained as the relative efficiency of an individual firm to the meta-frontier ($D_o^k(x^k, y^k)$) which can be decomposed into two components: one component measures the distance from input-output points to the group frontier ($D_o^{G,k}(x^k, y^k)$) representing the state of knowledge and the physical, social and economic environment that characterises groups, and the other measures the gap from the group frontier to the meta-frontier ($MTR(x^k, y^k)$).

From a Vietnamese banking perspective, Equation 4.6 is useful to assess the possible payoffs from policies of the Vietnamese Government on the operating environment of bank groups classified by ownership through the group MTR. The larger the value of this ratio the closer the distance from the group frontier to the meta-frontier, indicating that the group operates in a better physical, social and economic environment than the others.

4.3 DEA technical efficiency

4.3.1 Measuring technical efficiency

Charnes *et al.* (1978) developed the so-called Data Envelopment Analysis (DEA) method to measure the technical efficiency of firms. This method uses a linear programming technique to maximise a ratio of the weighted average output index to a weighted average input index for each firm with constraints which bound the same ratios of all firms to not exceed unity. They assume that all firms operate at optimal size and the technology has constant returns to scale. However, there are market limitations, such as imperfect competition and government regulations on the operation of firms, that inhibit them from achieving optimal size. Thus, the assumption of constant returns

to scale seems to be inappropriate in many circumstances. Banker *et al.* (1984) proposes an alternative assumption of variable returns to scale by adding a convexity constraint. Under the latter assumption the overall efficiency of firms can be established by two components. The first is pure technical efficiency component reflecting the ability of managers to utilise the firm's resources at a given scale, while the second efficiency component (so-called scale efficiency) measures the gap between the firm's temporary scale and the optimal scale.

Under the assumption of free disposability of inputs and outputs and variable returns to scale[52], the DEA estimate of the production set can be defined as:

$$\widehat{\wp} = \left\{(x, y) \in \mathbb{R}_+^p \times \mathbb{R}_+^q : \sum_{k=1}^n z_k y_k^i \geq y^i, i = 1, \dots, q;\ \sum_{k=1}^n z_k x_k^j \leq x^j, j = 1, \dots, p;\ \sum_{k=1}^n z_k = 1, z_k \geq 0\right\} \qquad (4.7)$$

Farrell's measure of technical efficiency (δ) is the reciprocal of the distance function (Simar and Wilson, 2007). The DEA output-oriented estimator of δ can be written in terms of the linear program as:

$$\hat{\delta} = \delta(x, y \in \widehat{\wp}) = max\left\{\delta > 0 : \sum_{k=1}^n z_k y_k^i \geq \delta y^i, i = 1, \dots, q;\ \sum_{k=1}^n z_k x_k^j \leq x^j, j = 1, \dots, p;\ \sum_{k=1}^n z_k = 1, z_k \geq 0\right\} \qquad (4.8)$$

[52]The constant returns to scale assumption is only appropriate when all firms are operating at their optimal scale (Charnes *et al.*, 1978). In the banking sector, banks are strongly impacted by regulations imposed by central banks such as regulations on capital adequacy and loan-loss provisioning. Furthermore, in the case of Vietnam, private banks are discriminated against compared to state-owned banks, causing an unfair and imperfect business environment amongst different bank groups. Consequently, Vietnamese banks may not perform at their optimal scale. Hence, this research chooses the assumption of variable returns to scale when measuring the technical efficiency of banks in the Vietnamese banking system.

Equation 4.8 can be used to estimate the technical efficiency scores of Vietnamese banks. The estimation for each individual bank will be conducted by scaling the distances to the meta-frontier and the group frontier.

Bootstrapping in DEA

While DEA has a number of advantages, such as being able to be applied to small sample sizes and using multiple outputs, it does not allow for random errors and, due to its non-parametric nature, it cannot be used to test for the statistical significance of estimates of technical efficiency scores. Furthermore, estimates of distances to production frontiers can be underestimated due to an inherent problem with mainstream DEA analysis, which is that not all efficient firms within the population are included in the sample (Coelli *et al.*, 2005; Simar and Wilson, 1998; 1999; 2007). In a graphical context, estimated frontiers are downward-biased in comparison with the true frontiers. Consequently, estimators of technical efficiency scores based on the estimated frontiers can be biased. So far, bootstrap methods seem to be the only viable alternative that can overcome the downward-biased nature of DEA estimates and to make inferences on $\delta(x, y)$ (Simar and Wilson, 2015).

Simar (1992) was the first to suggest applying bootstrap techniques in the production frontier framework for parametric, nonparametric and semi-parametric approaches (cited in Xue and Harker, 1999; Casu and Molyneux, 2003; Simar and Wilson, 2015). Bootstrapping is based on the idea that, through resampling, the data generating process is repeatedly simulated to make an arbitrary number of simulated samples. These

samples can then be utilised to generate simulated estimates[53]. The known bootstrap distribution of the resulting estimates will mimic the unknown sampling distribution of the original estimator (Simar and Wilson, 1998). Based on the simulated estimates we can derive bias-corrected estimators as well as confidence intervals for the true technical efficiency.

In the next part of this chapter, two bootstrap methods will be presented. First, sub-sampling bootstrapping will be applied to find confidence intervals for group technical efficiency. Second, parametric bootstrapping will be used to determine the statistical properties of coefficients in a double-bootstrap two-stage DEA procedure.

4.3.2 Measuring group technical efficiency

Many studies have applied the simple average method to estimate and compare group efficiency scores and, based on this, they may conclude that one group is more efficient than others (Das and Ghosh, 2006; Ataullah and Le, 2006; Denizer *et al*., 2007; Sufian and Habibullah, 2011). Their conclusion, however, introduces two issues. First, they ignore the relative importance of particular firms in each group as all firms are deemed to be the same. Second, they use point estimates for group efficiency scores to compare between different groups. Hence, it is possible to make inference errors (Simar and Zelenyuk, 2007).

The first issue will be addressed by the weighted average method if the weight of each firm in each group is appropriately identified. Based on the theory of economic optimisation, Färe and Zelenyuk (2003) propose that industry efficiency is the average

[53] In this thesis linear programming is used to generate bootstrap efficiency scores from simulated input/output data.

of the efficiency of individual firms with the weight equal to their cost or revenue shares in the industry.[54] Their theorem is that "an industry maximum revenue is the sum of its firms' maximal revenues" (Färe and Zelenyuk, 2003, p.615). This theorem is adapted in the context of groups by Simar and Zelenyuk (2007) and becomes "the maximal revenue of the groups of firms is equal to the sum of the maximal revenue of all its member firms" (Simar and Zelenyuk, 2007, p.1371). The new theorem can be used to acquire several important results for efficiency aggregating. The first is that the revenue efficiency of a group is equal to the weighted sum of individual firm revenue efficiency where the weight is the revenue share of firms in the group. The second is that the aggregate technical efficiency of a group is equal to the weighted sum of the firm technical efficiency (where the weight is that of revenue shares).

As mentioned above, bootstrap methods can be used to make a statistical inference of a firm's technical efficiency. Accordingly, the second issue can also be circumvented if these methods are applied in the context of groups and can provide confidence intervals for aggregate technical efficiency. The following presents the algorithm proposed by Simar and Zelenyuk (2007) to measure bias-corrected aggregate efficiency scores of groups using subsampling bootstrapping in a DEA context. Kneip *et al*. (2003) offer the subsampling bootstrap technique[55] for DEA which has proven to be consistent, simple and faster to compute than others.

This thesis first utilises the method of aggregating technical efficiency by Simar and Zelenyuk (2007) to measure and compare the performance of different bank ownership

[54] This thesis applies revenue shares.
[55] Subsampling bootstrapping is a bootstrap technique of generating subsamples by replacement from an original sample (for any subsamples that have a smaller size than the original sample).

types (state-owned banks, private banks and foreign and joint venture banks) in a particular country.

Algorithm of subsampling bootstrap of aggregates of DEA efficiency scores:

Step 1:

(i) Apply Equation 4.8 to the original sample $\Xi_n = \{(x^k, y^k): k = 1, \dots, n\}$ in order to obtain estimates of the true efficiency scores $\{\delta(x_k, x_k): k = 1, \dots, n\}$, and denote these estimates as $\{\hat{\delta}^k: k = 1, \dots, n\}$.

(ii) Partition the original sample into L distinct groups$\Xi_{n_l} = \{(x^{l,k}, y^{l,k}): k = 1, \dots, n_l\}$and $\{\hat{\delta}^{l,k}: k = 1, \dots, n_l\}, l \in \{1, \dots, L\}$representing the corresponding groups within the sample. Obtain estimates of the aggregate efficiency scores,$\overline{\hat{\delta}^l}$, for each group $l \in \{1, \dots, L\}$.

$$\overline{\hat{\delta}^l} = \sum_{k=1}^{n_l} \hat{\delta}^{l,k}.S^{l,k} \qquad (4.9)$$

where$S^{l,k} = \frac{py^{l,k}}{p\sum_{k=1}^{n_l} y^{l,k}}, k = 1, \dots, n_l$; and

p is the price vector.

If price information is unavailable, then use:

$$S^{l,k} = \left. \frac{\frac{1}{M}\sum_{m=1}^{M} \frac{y_m^{l,k}}{\sum_{l=1}^{L}\sum_{k=1}^{n_l} y_m^{l,k}}}{S^l} \right. \qquad (4.10)$$

where $S^l = \frac{1}{M}\sum_{m=1}^{M} \frac{\sum_{k=1}^{n_l} y_m^{l,k}}{\sum_{l=1}^{L}\sum_{k=1}^{n_l} y_m^{l,k}}$; and

M is the number of directions of vector *y*.

Step 2:

Obtain the bootstrap sequence $\Xi^*_{s_l,b} = \{(x_b^{*l,k}, y_b^{*l,k}): k = 1, \dots, s_l\}$ by subsampling with replacement from the corresponding group$\Xi_{n_l}$where s_l is the size of the subsample and $s_l < n_l$.

Step 3:

Establish a bootstrapped sample $\Xi^*_b$by incorporating all bootstrap sequences obtained from step 2, and use this bootstrap sample to estimate bootstrap technical efficiency scores by DEA, call them$\hat{\delta}_b^{*l,k}$, for $k = 1, \dots, s_l; l = 1, \dots, L$.

Step 4:

Compute the bootstrap estimates of the aggregate efficiency scores by:

$$\overline{\hat{\delta}_b^{*l}} = \sum_{k=1}^{s_l} \hat{\delta}_b^{*l,k}.S_b^{*l,k}, \qquad (4.11)$$

where$S_b^{*l,k} = \frac{p y_b^{*l,k}}{p \sum_{k=1}^{s_l} y_b^{*l,k}}$ $k = 1, \dots, s_l$

If price information is unavailable, then use:

$$S_b^{*l,k} = \left. \frac{1}{M} \sum_{m=1}^{M} \frac{y_{m,b}^{*l,k}}{\sum_{l=1}^{L} \sum_{k=1}^{s_l} y_{m,b}^{*l,k}} \right/ S_b^{*l} \qquad (4.12)$$

where$S_b^{*l} = \frac{1}{M} \sum_{m=1}^{M} \frac{\sum_{k=1}^{s_l} y_{m,b}^{*l,k}}{\sum_{l=1}^{L} \sum_{k=1}^{s_l} y_{m,b}^{*l,k}}$ $l = 1, \dots, L$; and

M is the number of directions of vector *y*.

Step 5:

Repeat step 3 to step 4 *B* times $(b: 1, \dots, B)$ so we have *B* bootstrap estimates of the aggregate efficiency scores for each group l $(l: 1, \dots, L)$.

Using the *B* bootstrap estimates from step 4 $\left(\overline{\hat{\delta}_b^{*l}}\right)$ and aggregate efficiency scores from step 2 $\left(\overline{\hat{\delta}^l}\right)$, we can compute the bias of aggregate efficiency scores and bias-corrected aggregate efficiency scores $\left(\overline{\hat{\delta}^l}\right)$ as below:

$$Bias\left(\overline{\hat{\delta}^{*l}}\right) = E\left(\overline{\hat{\delta}^{*l}}\right) - \overline{\hat{\delta}^l} \quad (4.13)$$

By substituting $E\left(\overline{\hat{\delta}^{*l}}\right) \approx \frac{1}{B}\sum_{b=1}^{B} \overline{\hat{\delta}_b^{*l}}$, we get:

$$\overline{\hat{\delta}^l} = \overline{\hat{\delta}^l} - Bias\left(\overline{\hat{\delta}^{*l}}\right) \approx 2\overline{\hat{\delta}^l} - \frac{1}{B}\sum_{b=1}^{B} \overline{\hat{\delta}_b^{*l}} \quad (4.14)$$

To compute the confidence interval for the aggregate efficiency scores of groups $(\overline{\delta^l})$ at α degree of significance, we sort in ascending order the list of $\left(\overline{\hat{\delta}_b^{*l}} - \overline{\hat{\delta}^l}\right) b = 1, \dots, B$ and truncate by deleting $\left((\alpha/2)x100\%\right)$ of the *B* elements at each end of the sorted list. If the first left element of the sorted truncated list is $-\hat{a}_{\propto}$ and the first right element is $-\hat{b}_{\propto}$ then we have:

$$P\left(-\hat{a}_{\propto} < \overline{\hat{\delta}_b^{*l}} - \overline{\hat{\delta}^l} < -\hat{b}_{\propto}\right) = 1 - \alpha \quad (4.15)$$

According to Simar and Wilson (2000; 2007), where the bootstrap constructed intervals automatically account for bias and the bootstrap is consistent, then:

$$\overline{\hat{\delta}^{*l}} - \overline{\hat{\delta}^{l}} \sim \overline{\hat{\delta}^{l}} - \overline{\delta^{l}} \qquad (4.16)$$

From Equations 4.15 and 4.16, we have:

$$P\left(-\hat{a}_{\propto} < \overline{\hat{\delta}^{l}} - \overline{\delta^{l}} < -\hat{b}_{\propto}\right) = 1 - \alpha \text{or}$$

$$P\left(\overline{\hat{\delta}^{l}} + \hat{b}_{\propto} < \overline{\delta^{l}} < \overline{\hat{\delta}^{l}} + \hat{a}_{\propto}\right) = 1 - \alpha$$

With a significance level of α the confidence interval of the true aggregate efficiency scores of groups is:

$$\left(\overline{\hat{\delta}^{l}} + \hat{b}_{\propto}; \overline{\hat{\delta}^{l}} + \hat{a}_{\propto}\right) \qquad (4.17)$$

Finally, the standard error of DEA aggregate efficiency scores of groups $\left(\overline{\hat{\delta}^{l}}\right)$ can be computed as:

$$SE\left(\overline{\hat{\delta}_{b}^{*l}}\right) = \left[\frac{1}{B-1}\sum_{b=1}^{B}\left(\overline{\hat{\delta}_{b}^{*l}} - E\left(\overline{\hat{\delta}^{*l}}\right)\right)^{2}\right]^{1/2} \qquad (4.18)$$

Test for equality of two groups' aggregate efficiency scores

In reality, it is important to compare the aggregate efficiency scores of two groups of a sample divided by exogenous criteria. This thesis applies the bootstrap-based test of Simar and Zelenyuk (2007) to investigate the equality of aggregate efficiency scores between: private and state-owned banks; foreign/joint venture and private banks; and foreign/joint venture and state-owned banks in Vietnam. In brief, there are two groups (group *A* and *Z*) used to compare aggregate efficiency scores. We can postulate:

$$H_o: \overline{\delta^{A}} = \overline{\delta^{Z}} \text{against} H_1: \overline{\delta^{A}} \neq \overline{\delta^{Z}} \qquad (4.19)$$

Due to the multiplicative nature of efficiency, Simar and Zelenyuk (2007) propose estimating the ratio of the group A aggregate efficiency score over the group Z aggregate efficiency score: $RD_{A,Z} = \frac{\overline{\delta^A}}{\overline{\delta^Z}}$ and the DEA estimate is computed as $\widehat{RD}_{A,Z} = \frac{\overline{\widehat{\delta}^A}}{\overline{\widehat{\delta}^Z}}$. While we cannot use this point estimate to provide any decisions on the equality of the two groups' aggregate efficiency scores due to inference errors, we can use the bootstrap confidence interval for testing. For elaborating a bootstrap confidence interval at α degree of significance, we can compute the bootstrap $RD_{A,Z}$ by using the results from step 4, as below:

$$\widehat{RD}^*_{A,Z,b} = \frac{\overline{\widehat{\delta}^{*A}_b}}{\overline{\widehat{\delta}^{*Z}_b}}, b = 1, \dots, B \qquad (4.20)$$

Based on the obtained bootstrap $RD_{i,j}$ list and the valuesof $\widehat{RD}_{i,j}$, bootstrap bias-corrected estimates of $RD_{i,j}$ are computed as:

$$\widetilde{RD}_{i,j,b} = 2\widehat{RD}_{i,j} - \widehat{RD}^*_{i,j,b} \qquad (4.21)$$

Based on the values of $\widetilde{RD}_{i,j,b}$ the lower and upper bound (confidence interval) of $RD_{i,j}$ at α degree of significance can be identified. The obtained $\widetilde{RD}_{i,j,b}$ list is sorted in ascending order and then truncated by deleting $\left((\alpha/2)x100\%\right)$ of the B elements at each end of the sorted list. The lower bound of $RD_{A,Z}$ is the first left element of the truncated sorted list and the upper bound is the first right element. After identifying the confidence interval at α degree of significance for $RD_{A,Z}$, we can then conclude which hypothesis is rejected using the rule:

Reject H_o if the confidence interval for $RD_{A,Z}$ does not overlap unity and do not reject otherwise. In particular, if the confidence interval lies above unity then we can conclude that $\overline{\delta^A} > \overline{\delta^Z}$.

The Simar and Zelenyuk (2007) test is limited to industries consisting of two groups but the number of groups in this study is three. Hence, the test is further developed by dividing the groups into three pairs (JSB versus SOCB; JSB versus FJVB; and SOCB versus FJVB) and conducting three comparisons of efficiency in the unique computing process[56].

4.3.3 Regressing environmental variables on technical efficiency

After estimating the efficiency scores of the firms one critical question arises: how to explain the variations of DEA scores. In the literature, regression analysis has been widely used to analyse DEA efficiency scores by specifying a regression model in which the variation of firms' estimates are explained by a set of environmental variables, such as type of ownership, size, location and age of firms (Das and Ghosh, 2006; Simar and Wilson, 2007). One can generalise the abovementioned approach by means of a two-stage DEA procedure as follows:

Stage 1:

Estimate efficiency scores by means of DEA based upon given inputs and outputs.

Stage 2:

[56] The process is performed using the author's modified Matlab codes based on the codes of Simar and Zelenyuk (2007) that apply for a two-group industry.

Regress the DEA estimates against a group of explanatory variables by a given regression method (e.g., OLS, Tobit or truncated regression). The results received will be used to analyse the relationship between the efficiency scores and the explanatory variables. However, there are some serious problems related to the OLS and Tobit methods (Simar and Wilson, 2007). The first is that all DEA estimates based on a finite sample are downward-biased (Simar and Wilson, 1998; Kneip*et al.*, 1998; 2008). This is because "best practice" observations in the sample are employed to construct the production frontier rather than true efficient but unobservable observations. Consequently, coefficients derived from the second stage can also be biased. Secondly, the DEA methodology ensures that efficiency scores are inherently dependent because of the calculation process which requires the involvement of all other firms to estimate the efficiency score of a firm (Xue and Harker, 1999). Bootstrapping is a unique way to simultaneously solve these two problems. Through bootstrapping, bias-corrected efficiency scores have been proven to be consistent with the true ones (Kneip*et al*, 1998; 2008). By employing bias-corrected efficiency scores instead of the DEA estimates at the regression stage, the coefficients generated are consistent. Bias-corrected efficiency scores are randomly generated in a bootstrap procedure so that they are independent and more accurate (Simar and Wilson, 2015). Even when problems relating to estimated DEA efficiency scores are disentangled, there is some doubt about what is being estimated in the two-stage approach since no data generating process[57] is described. Simar and Wilson (2007) propose an algorithm based on a double bootstrap procedure which enables a consistent inference in the second stage of regression. Before Simar and Wilson (2007), there were no studies describing the underlying data

[57] Based on assumptions given by the authors, a data generating process describes how data, including inputs, outputs and environmental variables, are generated and how they interact.

generating process. The procedure developed by Simar and Wilson (2007) using double resampling residual bootstraps with truncated regression in the second stage overcomes the above limitations. The procedure is characterised by the following assumptions:

Let $x \in \mathbb{R}_+^p$ denote a $(1 \times p)$ vector of inputs, $y \in \mathbb{R}_+^q$ denote a $(1 \times q)$ vector of outputs, and $z \in \mathbb{R}_+^r$ denote a $(1 \times r)$ vector of environmental variables. The analysis is confronted with a set of observations $\wp_n = \{(x_i, y_i, z_i)\}_{i=1}^n$.

Assumption 1: *The sample observations x_i, y_i, z_i in $\wp_n$ are realisations of identical, independently distributed random variables with a probability density function f(x,y,z) which has support over $\mathcal{P} \times \mathbb{R}_+^r$, where $\mathcal{P} \in \mathbb{R}_+^{p+q}$ is a production set defined by* $\mathcal{P} = \{(x, y): x\ can\ produce\ y\}$

Due to the radial nature of DEA efficiency scores it is appropriate to present *y* in terms of its polar coordinates when expressing the modulus from the boundary of the production set $\mathcal{P}$. For an arbitrary point(x_o, y_o), and $y_o = [y_{o1}, \dots, y_{oq}]$, we can define its modulus ω and angles η as:

$$\eta_{oj} = \begin{cases} arctan(y_{o,j+1}/y_{o,j})\ for\ y_{o1} > 0, \\ \pi/2 \qquad\qquad if\ y_{o1} = 0, \end{cases} \tag{4.22}$$

for $j = 1, \dots, q-1$.

The modulus is given by $\omega(y_o) = \sqrt{y_o' y_o}$ which is related to the output-oriented Farrell efficiency by $\delta(x_o, y_o\ /\ \mathcal{P}) = \frac{\omega(\delta(x_o, y_o/\mathcal{P})y_o)}{\omega(y_o)}$

This is because $\mathcal{P}$ is fixed so that we can characterise y_o by (η_o, δ_o) where $\eta_o = [\eta_{o,1}, \dots, \eta_{o,q-1}]$and $\delta_o = \delta(x_o, y_o\ /\ \mathcal{P})$.

The joint density $f(x, y, z)$ is equal to $f(x, \eta, \delta, z)$, and can be decomposed by a series of conditional densities:

$$f(x, \eta, \delta, z) = f(x, \eta/\delta, z) f(\delta/z) f(z) \qquad (4.23)$$

Assumption 2:*The conditioning in $f(\delta_i/z_i)$ operates through the following mechanism:*

$$\delta_i = \psi(z_i, \beta) + \varepsilon_i \geq 1 \qquad (4.24)$$

whereψ is a smooth continuous function, β is a vector of parameters and ε_i is a continuous iid random variable independent of z_i.

Assumption 3: *ε_i is distrubted $N(0, \sigma_\varepsilon^2)$ with left-truncation at $1 - \psi(z_i, \beta)$ for each i.*

Assumption 4: *$\mathcal{P}$ is closed and convex.*

Assumption 5:$(\mathrm{x}, \mathrm{y}) \notin \mathcal{P}$if $\mathrm{x} = 0, \mathrm{y} \geq 0$.

Assumption 6:*for $\tilde{x} \geq x, \tilde{y} \leq y$, if $(x, y) \in \mathcal{P}$ then $(\tilde{x}, y) \in \mathcal{P}$ and $(x, \tilde{y}) \in \mathcal{P}$.*

Assumption 7:*for all $(x, y) \in \mathcal{P}$ such that $(\theta^{-1}x, y \notin \mathcal{P})$ and $(x, \theta y \notin \mathcal{P})$for $\theta > 1$, f(x,y/z) is strictly positive, and f(x,y/z) is continuous in any direction toward the interior of $\mathcal{P}$ for all z.*

Assumption 8: *for all (x,y) in the interior of $\mathcal{P}$, $\delta(x, y/\mathcal{P})$ is differentiable in both its arguments.*

Assumptions 1 – 3 identify the environmental variables in the data generating process. Assumptions 4-6 are based on the microeconomic theory of the firm. The last two assumptions relate to the continuity of the density function. All eight assumptions

define a semi-parametric data generating process which yields data for the observed sample.

Taking all mentioned assumptions as the theoretical framework, Simar and Wilson (2007) propose a double-bootstrap algorithm to overcome the problems arising from serial correlation and the bias of DEA estimates. The algorithm is described below.

Double-bootstrap algorithm:

Step 1:

Use the original data in $\mathcal{P}_n = \{x_i, y_i\}_{i=1}^n$ to compute $\hat{\delta}_i = \hat{\delta}\left(x_i, y_i \backslash \hat{\mathcal{P}}\right) \forall i = 1, \dots, n$ by DEA.

Step 2:

Use the method of maximum likelihood to obtain an estimate $\hat{\beta}$ of β as well as an estimate $\hat{\sigma}_\varepsilon \, of \, \sigma_\varepsilon$ in the truncated regression of $\hat{\delta}_i$ on z_i using $m<n$ observations when $\hat{\delta}_i > 1$.

Step 3:

Loop over the next four steps (i-iv) L_1 times to obtain n sets of bootstrap estimates $\mathcal{B}_i = \{\hat{\delta}_{ib}^*\}_{b=1}^{L_1}$:

(i) For each $i = 1, \dots, n$ draw ε_i from the $N(0, \hat{\sigma}_\varepsilon^2)$ distribution with left-truncation at $(1 - z_i\hat{\beta})$.

(ii) Again for each $i = 1, \dots, n$, compute $\delta_i^* = z_i\hat{\beta} + \varepsilon_i$.

(iii) Set $x_i^* = x_i, y_i^* = y_i\hat{\delta}_i/\delta_i^*$ for all $i = 1, \dots, n$.

(iv) Compute$\hat{\delta}_i^* = \delta(x_i, y_i) \backslash \hat{\mathcal{P}}^* \forall i = 1, \ldots, n$ where $\hat{\mathcal{P}}^*$ is obtained from step 3 (iii).

Step 4:

For each $i = 1, \ldots, n$ compute the bias-corrected estimator $\hat{\hat{\delta}}_i$ using the bootstrap estimates in $\mathcal{B}_i$ obtained in step 3 (iv) and the original estimate $\hat{\delta}_i$.

Step 5:

Use the method of maximum likelihood to estimate the truncated regression of $\hat{\hat{\delta}}_i$on z_i, yielding estimate $\hat{\hat{\beta}}, \hat{\hat{\sigma}}$.

Step 6:

Loop over the next three steps (i-iii) L_2 times to obtain a set of bootstrap estimates $\mathcal{C} = \{(\hat{\beta}^*, \hat{\sigma}_\varepsilon^*)_b\}_{b=1}^{L_2}$:

(i) For each $i = 1, \ldots, n$ draw ε_i from the $N(0, \hat{\hat{\sigma}})$ distribution with left-truncation at $(1 - z_i\hat{\hat{\beta}})$.

(ii) Again for each $i = 1, \ldots, n$, compute $\delta_i^{**} = z_i\hat{\hat{\beta}} + \varepsilon_i$.

(iii) Use the method of maximum likelihood to estimate the truncated regression of δ_i^{**}on z_i, yielding estimate $(\hat{\hat{\beta}}^*, \hat{\hat{\sigma}}^*)$.

Step 7:

Use the bootstrap values in $\mathcal{C}$ and the original estimate $\hat{\hat{\beta}}, \hat{\hat{\sigma}}$ to construct estimated confidence intervals for each element of β andσ_ε.

Using steps 3 and 4, estimate the bootstrap technical efficiency scores $\hat{\delta}_{i,b}^{*}, b = 1, \dots, B$, and based on the bootstrap estimates compute the bias $\left(BIAS\left(\hat{\delta}_{i,b}^{*}\right)\right)$and the bias-corrected efficiency scores $\left(\hat{\hat{\delta}}_i\right)$as:

$$BIAS\left(\hat{\delta}_{i,b}^{*}\right) = \frac{1}{B}\sum_{b=1}^{B}\hat{\delta}_{i,b}^{*} - \hat{\delta}_i, for\ i = 1, \dots, n \qquad (4.25)$$

$$\hat{\hat{\delta}}_i = \hat{\delta}_i - BIAS\left(\hat{\delta}_{i,b}^{*}\right) = 2\hat{\delta}_i - \frac{1}{B}\sum_{b=1}^{B}\hat{\delta}_{i,b}^{*} \quad (4.26)$$

Employing the bootstrap values obtained in step 6 and bias-corrected values $\hat{\hat{\beta}}, \hat{\hat{\sigma}}$ we can construct the confidence intervals of β and σ at α level of significance. First, we sort the bias of bootstrap coefficients, which is equal to $\left(\hat{\hat{\beta}}_j^{*} - \hat{\hat{\beta}}_j\right)$ in an ascending order list and then truncate by deleting $\left((\alpha/2)x100\%\right)$ of the B elements at each end of the sorted list. Denoting $-b_\alpha^{*}$ and $-a_\alpha^{*}$ as the first left and first right values of the sorted truncated list we then have:

$$P\left[-b_\alpha^{*} \le \left(\hat{\hat{\beta}}_j^{*} - \hat{\hat{\beta}}_j\right) \le -a_\alpha^{*}\right] = 1 - \alpha \qquad (4.27)$$

andSimar and Wilson (2007) prove that $\left(\hat{\hat{\beta}}_j^{*} - \hat{\hat{\beta}}_j\right)$ approximates $\left(\hat{\hat{\beta}}_j - \beta_j\right)$ as $L_2 \to \infty$, so that $P\left[-b_\alpha^{*} \le \left(\hat{\hat{\beta}}_j - \beta_j\right) \le -a_\alpha^{*}\right] \approx P\left[-b_\alpha^{*} \le \left(\hat{\hat{\beta}}_j^{*} - \hat{\hat{\beta}}_j\right) \le -a_\alpha^{*}\right] = 1 - \alpha$

The confidence interval of β_j at α level of significance can be identified as:

$$\left[\hat{\hat{\beta}}_j + a_\alpha^{*}, \hat{\hat{\beta}}_j + b_\alpha^{*}\right]. \qquad (4.28)$$

The same computational process can be applied to standard error σ_ε.

The simulation requires repeating bootstrap-sampling processes many times in order to generate bootstrap samples. A critical question emerges of how many replications are sufficient. In regards to the number of bootstrap replications used to compute the bias-corrected estimates $\hat{\hat{\delta}}_i$, Simar and Wilson (2007) found that 100 replications are typically sufficient. Nonetheless, more information is needed for the bootstrapping process to estimate confidence intervals so that the number of replications is much bigger. Hall (1986) suggests 1000 replications for estimating confidence intervals. Following the works of Simar and Wilson (1998; 1999; 2007), in this thesis, 2000 replications are applied for both bootstrapping processes.

Combining double-bootstrap two-stage DEA with meta-frontier analysis

Ownership is frequently used as an explanatory variable in the literature to explain bank performance, along with other variables such as bank age and bank asset and profitability ratios (ROE, ROA, NIM). All earlier studies have considered ownership as an *ex-post* factor in regression models (see, for example, Kraft *et al*., 2006; Das and Ghosh, 2006; Sturm and Williams, 2004; Denizer *et al*., 2007; Kumbhakar and Wang, 2007; Berger *et al*., 2009; Azofra and Santamaria, 2011; Barry *et al*., 2011; Bertay *et al*., 2014; Strobel *et al*., 2014). These studies analyse the effect of ownership on bank performance using a two-stage process: first, all banks are pooled to measure their efficiency; and then bank efficiency is regressed on a set of environmental variables including ownership. Consequently, the impact of a particular variable on bank performance is similar regardless of ownership. This approach, however, seems to be inconsistent if bank ownership types respond differently to the same variable. The reason for this inconsistency is that bank groups under different ownership models may operate in environments which differentiate them by regulations, strategy, management

objectives and capability of accessing the production frontier. As mentioned in Section 4.1, Vietnamese banks are heterogeneous by ownership so that their performance may react diversely to the same policy changes or bank characteristics. Thus, it is reasonable to separate banks by ownership before measuring and regressing bank efficiency against a set of environmental variables. This can be implemented by combining the double-bootstrap two-stage DEA with meta-frontier analysis through a three step procedure suggested by the author of this thesis as below:

(1) Applying the double-bootstrap two-stage DEA for each group we can obtain DEA estimates and bias-corrected technical efficiency scores. The coefficients are also obtained reflecting the impact of environmental variables on efficiency within each group.

(2) A similar procedure is also implemented with the whole sample and equivalent results are also obtained.

(3) Using Equation 4.5 the meta-technology ratio (MTR) is calculated.

The aforementioned approach, seeing ownership as an *ex ante* factor, is adopted for the first time in this thesis in the context of the Vietnamese banking sector. Accordingly, each explanatory variable will be assessed for its influence on bank efficiency using the double-bootstrap two-stage DEA method in both the meta-frontier and group-frontier models.

4.4 Li test for equality of efficiency densities

Kneip *et al*. (1998) and Simar and Zelenyuk (2003) suppose that, under the same production set (or technology), all firms are able to access the meta-frontier but have

different accessibilities. They explain this issue by identifying different conditions faced by firms including regulation regime, ownership structure, business environment and various institutions, pertinent to different groups within the population. Under these different conditions a problem to consider is that one firm or one firm group may achieve the production frontier more easily than the others. In terms of the statistical framework, this problem is similar to the issue covered by Simar and Zelenyuk "the different marginal densities that generate technical (in)efficiency might be different across subgroups, even when they have a common best practice technology" (Simar and Zelenyuk, 2006, p.501). Consequently, investigating whether there is different accessibility to the frontier amongst various groups is equivalent to testing the hypothesis that their efficiency densities are different. Simar and Zelenyuk (2006) adapt the Li test to test this hypothesis.[58]

This study is the first to employ the bootstrap-Simar-Zelenyuk-adapted Li test to investigate the disparity of efficiency distributions between public, foreign and private banks in a particular country, in this case Vietnam. The three bank groups are organised into pairs to compare their efficiency densities. A brief description of the test is as follows:

There are two random samples, $\{x_{A,i}: i = 1, \dots, n_A\}$and $\{x_{Z,i}: i = 1, \dots, n_Z\}$, coming from potentially different distributions characterised at a point x^o by the density functions $f_A(x^o)$ and $f_Z(x^o)$ respectively. Our interest is to test the equality of the densities of the two samples *A* and *Z*. The hypotheses are as below:

[58]There are several tests used to identify the equality of two unknown densities; however, the Li test is asymptotically more powerful and computationally simpler. For more detail see Mammen (1992), Anderson *et al.* (1994), Li(1996, 1999), and Fan and Ullah (1999).

$H_0: f_A(x^o) = f_Z(x^o)$ (The densities of two groups *A* and *Z* are equal)

$H_1: f_A(x^o) \neq f_Z(x^o)$ (The densities of two groups *A* and *Z* are unequal)

To test the above hypotheses, Li (1996) proposes estimating the Integrated Square Difference (ISD):

$$ISD = \int [f_A(x) - f_Z(x)]^2 \, dx = \int [f_A^2(x) + f_Z^2(x) - 2f_A(x)f_Z(x)] \, dx$$

$$= \int f_A(x)dF_A(x) + \int f_Z(x)dF_Z(x) - \int f_A(x)dF_Z(x) - \int f_Z(x)dF_A(x) \quad (4.29)$$

Equation 4.29 satisfies the property that $ISD \geq 0$ and $ISD = 0$ if and only if H_0 is true ($f_A(x^o) = f_Z(x^o)$). A consistent and asymptotically normal estimator of Equation (4.29) is obtained by replacing the unknown distribution functions$\left(F_A(x) and\ F_Z(x)\right)$by empirical distribution functions (F_{A,n_A} and F_{Z,n_Z}).

$$F_{l,n_l}(x) \equiv \frac{1}{n_l}\sum_{k=1}^{n_l} I\left(x_{l,k} \leq x\right), l=A, Z \quad (4.30)$$

I(X) is an indicator function in which I(X) =1 if the statement X is true, and zero otherwise.

The unknown densities ($f_A(x)$and$f_Z(x)$)in Equation 4.29 are replaced with the nonparametric kernel density estimation $\hat{f}_{A,n_A}$ and$\hat{f}_{Z,n_Z}$:

$$\hat{f}_{l,n_l}(x) \equiv \frac{1}{n_l h_l}\sum_{k=1}^{n_l} K\left(\frac{x - x_{l,k}}{h_l}\right), l=A, Z \quad (4.31)$$

where$h_l = h(n_l)$ is a smoothing parameter, such that $h_l \to 0$ and $n_l h_l \to \infty$ as $n_l \to \infty$; and

K is an appropriate kernel density function (in this research a Gaussian density function is applied).

In the case where $h = \min(h_A, h_Z)$ and the "diagonal" term is removed, Equation 4.29 becomes:

$$ISD^{nd}_{n_A n_Z h} = \left\{ \frac{1}{h n_A (n_A - 1)} \sum_{i=1}^{n_A} \sum_{\substack{k=1 \\ i \neq k}}^{n_A} K\left(\frac{x_{A,i} - x_{A,k}}{h} \right) + \frac{1}{h n_Z (n_Z - 1)} \sum_{i=1}^{n_Z} \sum_{\substack{k=1 \\ i \neq k}}^{n_Z} K\left(\frac{x_{Z,i} - x_{Z,k}}{h} \right) \right.$$
$$\left. - \frac{1}{h n_Z (n_A - 1)} \sum_{i=1}^{n_A} \sum_{k=1}^{n_Z} K\left(\frac{x_{A,i} - x_{Z,k}}{h} \right) - \frac{1}{h n_A (n_Z - 1)} \sum_{i=1}^{n_Z} \sum_{\substack{k=1 \\ i \neq k}}^{n_A} K\left(\frac{x_{Z,i} - x_{A,k}}{h} \right) \right\} \quad (4.32)$$

It is possible to show that this estimator is asymptotically normal (Li, 1996), i.e:

$$J^{nd}_{n_A n_Z h} = \frac{n_A h^{1/2} ISD^{nd}_{n_A n_Z h}}{\sigma_{\lambda,h}} \xrightarrow{d} N(0,1) \quad (4.33)$$

and:

$$\sigma^2_{\lambda,h} = 2 \left\{ \frac{1}{n_A^2 h} \sum_{i=1}^{n_A} \sum_{k=1}^{n_A} K\left(\frac{x_{A,i} - x_{A,k}}{h} \right) + \frac{\lambda_n^2}{n_Z^2 h} \sum_{i=1}^{n_Z} \sum_{k=1}^{n_Z} K\left(\frac{x_{Z,i} - x_{Z,k}}{h} \right) \right.$$
$$\left. - \frac{\lambda_n}{n_Z n_A h} \sum_{i=1}^{n_Z} \sum_{k=1}^{n_A} K\left(\frac{x_{Z,i} - x_{A,k}}{h} \right) - \frac{\lambda_n}{n_A n_Z h} \sum_{i=1}^{n_A} \sum_{k=1}^{n_Z} K\left(\frac{x_{A,i} - x_{Z,k}}{h} \right) \right\} \int K^2(x) dx \quad (4.34)$$

where $\lambda_n = {}^{n_A}/_{n_Z}$; and

we assume that $\lambda_n \to \lambda$ as $n_A \to \infty$ where $\lambda \in (0, \infty)$is a constant.

The true efficiency scores, whose densities we want to compare, are unobservable but we can get estimates of these scores by DEA. However, the DEA estimates are

downward-biased and dependent (Simar and Wilson, 1998; Xue and Harker, 1999). Bootstrapping is the unique technique to overcome these limitations (Simar and Wilson, 2015). Li (1999) postulates a bootstrap procedure based on a resampling process from a sample which is proven to be consistent and demonstrates superior properties. Simar and Zelenyuk (2006) follow the Li (1999) bootstrap procedure in a DEA context.

Bootstrap-based p-values for the Li test can be obtained from:

$$\text{Bootstrap p-value} = \frac{1}{B}\sum_{b=1}^{B} \mathrm{I}(\hat{J}_{n_{A,n_Z}}^{nd,b} > \hat{J}_{n_{A,n_Z}}^{nd}) \quad (4.35)$$

where I is an indicator function yielding 1 if $\hat{J}_{n_{A,n_Z}}^{nd,b} > \hat{J}_{n_{A,n_Z}}^{nd}$ is true and 0 otherwise;

B is the number of bootstrap replications;

$\hat{J}_{n_{A,n_Z}}^{nd}$ is the Li-test statistic given above; and

$\hat{J}_{n_{A,n_Z}}^{nd,b}$ is its bootstrap analogue.

One difficulty when applying the Li test is the bound problem which is observed as "spurious mass at unity" due to the construction, and at least one observation will be on the estimated frontier. Simar and Zelenyuk (2006) provide two approaches to solve this problem. The first one is based on computation and bootstrapping the Li statistic using the sample of DEA estimates without those being equal to unity. However, using this method would reduce the sample size. The second uses the sample of DEA estimates where those equal to unity are "smoothed" away from the boundary by adding a small noise (ε^k).

Technical efficiency scores are identified as:

$$\tilde{\delta}^k = \begin{cases} \hat{\delta}^k + \varepsilon^k, if\, \hat{\delta}^k = 1 \\ \hat{\delta}^k, otherwise \end{cases} \quad (4.36)$$

where: $\varepsilon^k = Uniform\left(0, min\left\{n^{-\frac{2}{M+N+1}}, \alpha - 1\right\}\right)$; and

$\alpha$is the $\alpha - quantile$ (e.g., 5%) of the empirical distribution of $\left\{\hat{\delta}^k : \hat{\delta}^k > 1, k = 1, \dots, n\right\}$.

Simar and Zelenyuk (2006) propose a bootstrap algorithm for the Li test as below:

Step 1:

Consider an original sample which can be divided into two groups (*A* and *Z* groups) and compare the efficiency densities of these two groups. Estimate $\hat{\delta}^k(x^k, y^k)$ using DEA for each observation *k* of the original sample $S_n = \{(x^k, y^k) : k = 1, \dots, n\}$

Step 2:

Exclude efficiency scores equal to unity from the sample by applying the smoothing approach where the original estimates of efficiency scores are smoothed using Equation 4.35. Split the smoothed estimates of $\hat{\delta}^k(x, y)$ into two subsamples for group *A* and *Z*, thus obtaining the smoothed efficiency scores of each group:

$$\left\{\tilde{\delta}^{A,k} : k = 1, \dots, n_A\right\} \quad \text{(Subsample A1)}$$

and

$$\left\{\tilde{\delta}^{Z,k} : k = 1, \dots, n_Z\right\} \quad \text{(Subsample A2)}$$

Step 3:

Use the subsample efficiency scores to estimate the Li test statistic ($\hat{J}^{nd}_{n_{A,n_Z}}$) using Equation 4.33 with subsamples A1 and A2.

Step 4:

Resample[59] from the largest of subsamples A1 and A2 to obtain the bootstrap analogues of A1 and A2 and call them:

$$\{\tilde{\delta}^{*A,k}: k = 1, \dots, n_A\} \qquad \text{(Subsample A3)}$$

and

$$\{\tilde{\delta}^{*Z,k}: k = 1, \dots, n_Z\} \qquad \text{(Subsample A4)}$$

Step 5:

Repeat steps 2 and 3 to estimate the bootstrap Li test statistic ($\hat{J}^{nd,b}_{n_{A,n_Z}}$) using bootstrap subsamples A3 and A4.

Step 6:

Repeat steps 4 and 5 *B* times to obtain *B* bootstrap estimates of the Li test statistic.

The next section provides an application of the concept of aggregate technical efficiency to build an extension of the Malmquist productivity index.

4.5 Aggregate Malmquist Productivity Index (AMPI)

The objective of the abovementioned DEA models is to measure the efficiency of firms and, furthermore, to analyse the disparity of efficiency based on explanatory variables. Thus, these DEA models, by concentrating only on efficiency, are unable to identify the performance of firms over time. This is due to the fact that changes in firm performance (productivity) originate from two sources:

efficiency change - the capability of firms to catch up with best-practice peers under the reference technology (the same production frontier); and

[59] To conduct a resampling process from an original sample, see Li(1999).

technological change - the progress or regress of technology (forward or backward movement of the production frontier) over time.

(Färe *et al.,* 1994).

The most popular approach to measure productivity change is based on the Malmquist Productivity Index (MPI) (Zelenyuk, 2006). Caves *et al*. (1982a; 1982b) first introduced the MPI which is constructed by measuring distance functions of the observed output and input vectors in periods*s* to *t*, relative to a reference technology. The MPI can be output or input oriented depending on the orientation of distance functions. In this thesis, the MPI is output oriented.[60]

Most empirical research utilises averages of MPIs to present overall trends of productivity changes and equally weighted geometric means are used for this purpose. The limitation of such means, however, is that all firms are treated similarly; consequently, the relative importance of each firm is ignored despite the fact that the impact of different firms on the productivity of a group or an industry cannot be the same. Recently, methods of aggregating firm efficiency have developed to calculate aggregate technical efficiency of a group or an industry based on the theory of economic optimisation which can be used as a tool to overcome the above limitation. These methods account for the relative importance of individual firms by using their revenue or cost weights. According to Zelenyuk (2006), the work of Färe and Zelenyuk (2003), as mentioned in Subsection 4.3.2, on aggregating the technical efficiency of individual firms within an industry or a group of firms can be extended to aggregating MPI. For aggregating MPI, aggregate technical efficiency, measured by using the data of a period

[60]Output-oriented MPI is used because the distance functions applied in this study are output oriented (see Subsection 4.2.1).

can be extended intertemporally to identify a change of technology over the studied duration. It is worth noting that technology is a substantial factor influencing the productivity of a firm or an industry. The rest of this section will go in depth to describe MPI, methods to aggregate MPI and how to decompose AMPI into efficiency and technical changes for a particular group or industry.

Output-oriented Malmquist Productivity Index

We assume that at each time period, $t = 1, \dots, T$, the production technology transforms inputs presented by vector$x^t \in \mathbb{R}_+^p$ into outputs, $y^t \in \mathbb{R}_+^q$. The production technology at time t can be described as:

$$\wp^t = \{(x^t, y^t) \in \mathbb{R}_+^p \times \mathbb{R}_+^q : x^t \; can \; produce \; y^t\} \qquad (4.37)$$

Following Shephard (1970), an output-oriented distance function can be defined at time t for firm k as:

$$D_{ot}^k(x_t^k, y_t^k) = inf\{\theta^k : (x_t^k, y_t^k/\theta^k) \in \wp^t\} \qquad (4.38)$$

Our objective is to compare the change of productivity between two periods $t$and $t+1$. Thus, the distance functions with respect to two technologies in the two time periods need to be defined to observe the movement of the production frontier over time. One may define the distance function of input-output combinations at time t (x_t^k, y_t^k) with respect to time $t+1$ technology as:

$$D_{ot+1}^k(x_t^k, y_t^k) = inf\{\theta^k : (x_t^k, y_t^k/\theta^k) \in \wp^{t+1}\} \qquad (4.39)$$

Similarly, the input-output combinations at time $t+1$ with respect to time t technology can be identified as:

$$D_{ot}^{k}\left(x_{t+1}^{k}, y_{t+1}^{k}\right) = inf\left\{\theta^{k}: \left(x_{t+1}^{k}, y_{t+1}^{k}/\theta^{k}\right) \in \wp^{t}\right\} \qquad (4.40)$$

According to Caves *et al.* (1982a; 1982b), for a particular firm $k$the definition of MPI is based on either the technology of time t or $t+1$ as below:

$$M^{t} = \frac{D_{ot}^{k}(x_{t+1}^{k}, y_{t+1}^{k})}{D_{ot}^{k}(x_{t}^{k}, y_{t}^{k})} \text{and} M^{t+1} = \frac{D_{ot+1}^{k}(x_{t+1}^{k}, y_{t+1}^{k})}{D_{ot+1}^{k}(x_{t}^{k}, y_{t}^{k})} \qquad (4.41)$$

The value of $D_{ot}^{k}\left(x_{t}^{k}, y_{t}^{k}\right)$ is either smaller than or equal to unity. $D_{ot}^{k}\left(x_{t+1}^{k}, y_{t+1}^{k}\right)$is either smaller than or equal to unity in the case where the input-output combination $\left(x_{t+1}^{k}, y_{t+1}^{k}\right)$ locates inside the production set $\wp^{t}$, and the value is bigger than unity when the combination locates outside $\wp^{t}$. Hence, the value of M^{t} as a fraction with the numerator and denominator respectively denoted as $D_{ot}^{k}\left(x_{t+1}^{k}, y_{t+1}^{k}\right)$ and $D_{ot}^{k}\left(x_{t}^{k}, y_{t}^{k}\right)$ can be smaller, bigger or equal to unity. The same explanation can be applied to M^{t+1}.

Färe *et al.* (1994) state that the MPI change can be specified as the geometric mean of the two above indexes in order to avoid choosing an arbitrary benchmark. The change of MPI is defined as:

$$M_{o} = \left[\left(\frac{D_{ot}^{k}(x_{t+1}^{k}, y_{t+1}^{k})}{D_{ot}^{k}(x_{t}^{k}, y_{t}^{k})}\right)\left(\frac{D_{ot+1}^{k}(x_{t+1}^{k}, y_{t+1}^{k})}{D_{ot+1}^{k}(x_{t}^{k}, y_{t}^{k})}\right)\right]^{1/2} \qquad (4.42)$$

To be the geometric mean of $M^{t}$and M^{t+1}, the value of M_{o} can be smaller, bigger or equal to unity. Based on the value of M_{o}, the change of MPI can be explained differently. If $M_{o} > 1$ then the MPI has changed positively between the two periods ($t$and $t+1$) and the conclusion is negative when $M_{o} < 1$. The productivity is seen to be unchanged if $M_{o} = 1$.

The MPI change can be decomposed in order to take into account the changes of its components consisting of technology and efficiency. Equation 4.42 can be rewritten as:

$$M_o = \underbrace{\frac{D^k_{ot+1}(x^k_{t+1},y^k_{t+1})}{D^k_{ot}(x^k_t,y^k_t)}}_{Efficiency\ change\ (EFCH)} \underbrace{\left[\left(\frac{D^k_{ot}(x^k_t,y^k_t)}{D^k_{ot+1}(x^k_t,y^k_t)}\right)\left(\frac{D^k_{ot}(x^k_{t+1},y^k_{t+1})}{D^k_{ot+1}(x^k_{t+1},y^k_{t+1})}\right)\right]^{1/2}}_{Technical\ change\ (TECH)} \quad (4.43)$$

The ratio outside the square brackets measuring the change of the output-oriented measure of technical efficiency between two periods t and $t+1$ identifies how well a firm approaches the production frontier. EFCH can be smaller, bigger or equal to unity referring to firm efficiency decline, improvement or stagnation respectively. The second component, the geometric mean of the two ratios inside the square brackets, captures the shift of technology between the two periods. TECH can also be smaller, bigger or equal to unity indicating the firm's technology regression, progression or stagnation over time.

All the above discussion relates to how to measure and identify sources of MPI change for a specific firm. Thus, it is necessary to go further to measure the MPI and its component changes for a group of firms or an industry. A traditional method is to average the productivity indexes and components of all firms within a group or an industry by using the equally-weighted geometric mean. The limitation of this method is that it ignores the relative importance of individual firms in contributing to group/industry performance. As mentioned above, Färe and Zelenyuk (2003) developed a method for aggregating the technical efficiency of firms to construct a similar measure for groups/industries by using the theory of economic optimisation. This method can be further developed to incorporate the intertemporal analysis of efficiency, and so the movement of the production frontier (change of technology) of a group of firms or

industry can be observed between periods. The development of the aggregate MPI(AMPI) and decomposing it into aggregate component changes is outlined by Zelenyuk (2006).

The inter-temporal extension of Farrell's aggregate technical efficiency of a group or an industry is identified as:

$$\overline{\delta_\tau}(j) = \sum_{k=1}^{n}\left[D_{o\tau}^{k}\left(x_j^k, y_j^k\right)\right]^{-1}.S_j^k, \qquad j,\tau = t, t+1 \qquad (4.44)$$

where$\overline{\delta_\tau}(j)$ is the Farrell aggregate technical efficiency of a group or an industry at time j and measured by the technology at time τ;

$D_{o\tau}^{k}\left(x_j^k, y_j^k\right)$ is the Shephard technical efficiency of firm k at time j, measured by the technology at time τ; and

$S_j^k$is the revenue share of firm k at time j.

Based on Equations 4.44 and 4.42, AMPI can be defined as:

$$\overline{M_o} = \left[\left(\frac{\overline{\delta_t}(t+1)}{\overline{\delta_t}(t)} \times \frac{\overline{\delta_{t+1}}(t+1)}{\overline{\delta_{t+1}}(t)}\right)^{-1}\right]^{1/2} = \left[\left(\frac{\sum_{k=1}^{n}\left[D_{ot}^{k}(x_{t+1}^k, y_{t+1}^k)\right]^{-1}.S_{t+1}^k}{\sum_{k=1}^{n}\left[D_{ot}^{k}(x_t^k, y_t^k)\right]^{-1}.S_t^k} \times \right.\right.$$

$$\left.\left.\frac{\sum_{k=1}^{n}\left[D_{ot+1}^{k}(x_{t+1}^k, y_{t+1}^k)\right]^{-1}.S_{t+1}^k}{\sum_{k=1}^{n}\left[D_{ot+1}^{k}(x_t^k, y_t^k)\right]^{-1}.S_t^k}\right)^{-1}\right]^{1/2} \qquad (4.45)$$

AMPI can be decomposed into aggregate efficiency change (AEFCH) and aggregate technical change (ATECH) using Equation 4.43 as below.

$$\overline{M_o} = \underbrace{\left(\frac{\overline{\delta_{t+1}}(t+1)}{\overline{\delta_t}(t)}\right)^{-1}}_{aggregate\ efficiency\ change} \underbrace{\left[\left(\frac{\overline{\delta_t}(t)}{\overline{\delta_{t+1}}(t)} \times \frac{\overline{\delta_t}(t+1)}{\overline{\delta_{t+1}}(t+1)}\right)^{-1}\right]^{1/2}}_{aggregate\ technical\ change} \qquad (4.46)$$

In detail, AEFCH and ATECH can be defined as:

$$AEFCH = \left(\frac{\sum_{k=1}^{n} [D_{ot+1}^{k}(x_{t+1}^{k}, y_{t+1}^{k})]^{-1} . S_{t+1}^{k}}{\sum_{k=1}^{n} [D_{ot}^{k}(x_{t}^{k}, y_{t}^{k})]^{-1} . S_{t}^{k}} \right)^{-1} \quad (4.47)$$

and

$$ATECH = \left[\left(\frac{\sum_{k=1}^{n} [D_{ot}^{k}(x_{t}^{k}, y_{t}^{k})]^{-1} . S_{t}^{k}}{\sum_{k=1}^{n} [D_{ot+1}^{k}(x_{t}^{k}, y_{t}^{k})]^{-1} . S_{t}^{k}} \times \frac{\sum_{k=1}^{n} [D_{ot}^{k}(x_{t+1}^{k}, y_{t+1}^{k})]^{-1} . S_{t+1}^{k}}{\sum_{k=1}^{n} [D_{ot+1}^{k}(x_{t+1}^{k}, y_{t+1}^{k})]^{-1} . S_{t+1}^{k}} \right)^{-1} \right]^{1/2} \quad (4.48)$$

In this thesis, APMI is applied for the first time to measure changes in productivity of a banking sector. In particular, the productivity of the Vietnamese banking sector in aggregate and for each bank group (private, state-owned and foreign banks) are measured and the sources of these changes, including that of efficiency and technology factors, are also analysed.

4.6 Hicks−Moorsteen productivity index

Despite the fact that the Malmquist productivity index is the most popular measure of productivity change used in the literature (Nguyen and Simioni 2015) it is multiplicatively incomplete (O'Donnell, 2012a, b) and, consequently, cannot be decomposed into exhaustive measures of technical change and efficiency change. Furthermore, under the non-constant returns to scale condition the Malmquist index is

not able to measure productivity change precisely. It contains bias which is systemic and depends on the magnitude of scale economies (Coelli and Rao 2005). Ray and Desli (1997) and Wheelock and Wilson (1999) argue that when a firm's location (from one period to another) remains unchanged, and the changes in scale efficiency are only related to a shift in the variable returns to scale (VRS) estimate of technology, there will be no resulting technical change under CRS. Hence, the resulting CRS estimate of technology may be statistically inconsistent. Consequently, Wheelock and Wilson (1999) state that the popular decomposition of the Malmquist index conducted by Färe *et al*. (1994) is also problematic.

O'Donnell (2012a, b) has proven that productivity indices, including Laspeyres, Paasche, Fisher and Hicks−Moorsteen, are multiplicatively complete. The Hicks−Moorsteen index is chosen in this thesis as it does not require the availability of prices compared with the other mentioned indices.

For the purpose of this thesis, recent developments in the TFP index measurement and TFP index decomposition, as proposed by O'Donnell (2012a, b), are used. In the latter a general class of multiplicatively-complete TFP indexes is introduced. The TFP index is defined as the ratio of an aggregate output to an aggregate input, and the change in TFP can then be expressed as the ratio of an output quantity index to an input quantity index, i.e. a measure of output growth divided by a measure of input growth. This means that, for firm *n* in period *t*, TFP is given by:

$$TFP_{nt} = \frac{Y_{nt}}{X_{nt}}$$

where Y_{nt} and X_{nt} are, respectively, the aggregate output and aggregate input of the n^{th} firm in period *t*. This Hicks−Moorsteen index is in fact a ratio of Malmquist output and

input quantity indices, which is based on the works of Hicks (1961) and Moorsteen (1961):

$$TFP_{HM}^{t,t+1} = \left(\frac{D_o^{t+1}(x^{t+1}, y^{t+1}) D_o^t(x^t, y^{t+1})}{D_o^{t+1}(x^{t+1}, y^t) D_o^t(x^t, y^t)} \frac{D_I^{t+1}(x^t, y^{t+1}) D_I^t(x^t, y^t)}{D_I^{t+1}(x^{t+1}, y^{t+1}) D_I^t(x^{t+1}, y^t)} \right)^{1/2} \quad (4.49)$$

In Equation (4.49), $D_o(x, y)$ and $D_I(x, y)$ are output and input distance functions, respectively, defined as $D_O^T(x, y) = \min\left\{\delta > 0 : (x, y/\delta) \in P^T\right\}$, and $D_I^T(x, y) = \max\left\{\rho > 0 : (x/\rho, y) \in P^T\right\}$, where P^T is the period T production possibilities set. These distance functions can be calculated using Data Envelopment Analysis (DEA) models developed by O'Donnell (2012a).

The output-oriented decomposition of a multiplicatively complete TFP index for firm *n* in period *t* can be rewritten as:

$$TFP_{nt} = TFP_t^* \times OTE_{nt} \times OSME_{nt} \quad (4.50)$$

where TFP_t^* is the maximum TFP possible using any technically feasible inputs and outputs; OTE_{nt} (output-oriented technical efficiency) measures the difference between observed TFP and the maximum TFP that is possible while holding the input-output mix and input level fixed; $OSME_{nt}$ (output-oriented scale-mix efficiency) measures the change in productivity when restrictions on the output scale and output mix of the firm are relaxed.

There are two ways to decompose the $OSME_{nt}$. First, $OSME_{nt}$ can be decomposed into output-oriented mix efficiency (OME_{nt}) and residual output-oriented scale efficiency ($ROSE_{nt}$). The $OME_{nt}$is a measure of the increase of TFP that can be gained now by holding inputs fixed and relaxing restrictions on the output mix. The $ROSE_{nt}$ is a

measure of the difference between TFP at a technically and mix efficient point and TFP at the point of maximum attainable productivity. Second, $OSME_{nt}$ can be decomposed into output-oriented scale efficiency (OSE_{nt}) and residual mix efficiency (RME_{nt}). The OSE_{nt}measures the gain in TFP a firm can achieve by moving along the mix-invariant production frontier to the mix-invariant optimal scale point. The RME_{nt} measures the productivity gain when the technically and scale efficient firm achieves the mix-variant optimal scale point by changing its output mix.

Now the equation (4.50) can be rewritten as:

$$TFP_{nt} = TFP_t^* \times OTE_{nt} \times OME_{nt} \times ROSE_{nt} \quad (4.51)$$

or

$$TFP_{nt} = TFP_t^* \times OTE_{nt} \times OSE_{nt} \times RME_{nt} \quad (4.52)$$

Decompositions of TFP change

O'Donnell (2012a, b) showed that the TFP index that compares the productivity of the firm in period t and $t+1$ can be decomposed into a measure of technical change and various measures of efficiency change.

$$TFPI_{t,t+1} = \underbrace{\left(\frac{TFP_{t+1}^*}{TFP_t^*}\right)}_{Technical\ change} \underbrace{\left(\frac{OTE_{t+1}}{OTE_t}\right)\left(\frac{OME_{t+1}}{OME_t}\right)\left(\frac{ROSE_{t+1}}{ROSE_t}\right)}_{Measures\ of\ efficiency\ change} \quad (4.53)$$

or

$$TFPI_{t,t+1} = \underbrace{\left(\frac{TFP_{t+1}^*}{TFP_t^*}\right)}_{Technical\ change} \underbrace{\left(\frac{OTE_{t+1}}{OTE_t}\right)\left(\frac{OSE_{t+1}}{OSE_t}\right)\left(\frac{RME_{t+1}}{RME_t}\right)}_{Measures\ of\ efficiency\ change} \quad (4.54)$$

The term included in the first parentheses on the right-hand side of equations (4.53) and (4.54) represents technical changes, measuring the difference between the maximum TFP possible using any technology feasible at times *t* and *t+1*. Hence, the sector experiences technical improvement or decline, depending on whether $\frac{TFP_{t+1}^*}{TFP_t^*}$ is greater or

less than one. Unlike in the decomposition of the Malmquist index of Färe *et al*. (1994), the technical change contains a mixed effect, and, characteristically, varies from firm to firm. The three other ratios on the extreme right-hand side of equations (4.53) and (4.54) are various components of efficiency changes and are referred to as measures of technical-efficiency change, mix-efficiency change, and scale-efficiency change. The DPIN software written by O'Donnell (2011) is used to estimate different measures of efficiency and TFP components.

4.7 Summary

The DEA method proposed by Farrell (1957) and subsequently further developed by Charnes *et al*. (1978) is a popular method to estimate efficiency scores. DEA can not only measure the efficiency scores of individual firms but also firm groups through aggregation. This aggregate efficiency measure based on microeconomic theory will be used to estimate and compare the efficiency of state-owned, foreign and private bank groups in this thesis. Furthermore, the difference in bank group efficiency will be investigated through the Li test. Lastly, a double-bootstrap two-stage DEA is utilised to identify the possible relationship between bank efficiency and explanatory variables. Extending the concept of aggregate technical efficiency to incorporate inter-temporal analysis, we can measure total factor productivity indexes and component changes of the banking industry and bank groups over time.

One advantage of the methods and tests presented in this chapter is that most of them apply bootstrap techniques. As mentioned previously, DEA estimators can be downward-biased and inherently dependent so that the bootstrap technique is not just a good technique but also a unique technique to overcome these limitations.

Computational processes relating to DEA scores, aggregate DEA scores, regression analysis and test statistics used in this thesis are conducted using Matlab - the most common mathematical software[61].

This chapter contributes to the theory of bank efficiency in several ways. First, it shows how to apply the method of aggregating technical efficiency in a banking system to measure and compare bank efficiency and productivity. Second, this chapter has emphasised that the business environment in which banks operate can be different and that, consequently, this leads to different levels of access to the frontier across various types of bank ownership. The Li test is also employed as anoriginal measure for detecting and analysing this difference. Third, by combining a meta-frontier analysis with a double-bootstrap two-stage DEA, this study has suggested a new approach to analyse the impact of variables on bank efficiency in separate groups operating under different technologies. This thesis is the first to employ ownership as an *ex ante* rather than an *ex post* factor, which is how ownership has traditionally been used in all earlier studies when examining the influence of environmental variables on bank efficiency. The abovementioned approach has originated from the fact that different bank ownership forms can result in a divergence of technology sets utilised by bank groups and can result in different responses to the same explanatory variables (e.g, credit policy or loan to asset ratios).

The next chapter will describe the data to be used for the empirical analyses conducted in this thesis in terms of data sources and data statistical description. In addition, DEA

[61] The codes in Matlab were provided by Associate Professor Valentin Zelenyuk, University of Queensland, Australia.

models and environmental variables utilised to measure and analyse efficiency scores will be specified drawing upon the literature review conducted in Chapter 3.

Chapter 5: Data and analysis of Vietnamese banking efficiency

5.1 Introduction

The purpose of this chapter is to describe the data sources, specify the explanatory variables used in the regression models and conduct an empirical analysis of the technical efficiency of the Vietnamese banking sector in the years 2005–2012 encompassing the pre- and post-WTO entry periods.

The DEA method is applied to measure, compare and explain the technical efficiency and productivity of Vietnamese banks. To add value to the results obtained by other relevant studies (e.g., Vu and Turnell, 2010; Minh *et al*., 2013; Nguyen *et al*., 2014), this study employs the aggregate technical efficiency method, accounting for the relative importance[62] of individual banks, to measure the performance of three bank groups - state-owned banks, private banks and foreign banks - as well as the entire industry. To examine the difference of banking sector efficiency between the pre- and post-WTO periods, the Li (1996) test on the efficiency distribution and the Simar and Zelenyuk (2007) test of efficiency difference are also used. These two tests also allow us to examine efficiency differences between the different bank groups.

This chapter is structured as follows: Section 5.2 describes the data sources, sample, and specification of inputs, outputs and variables used in the DEA models for analysis of banking efficiency; Section 5.3 compares bank efficiency between the pre- and post-WTO entry periods using the Li (1996; 1999) and Simar and Zelenyuk (2007) tests; these two tests are also employed in Section 5.4 where the performance of bank groups

[62] The relative importance is quantified by the outcome shares when calculating the aggregate efficiency scores of groups (see Section 4.3.2).

are measured and compared; and lastly, a summary reviewing the chapter's contents is included in Section 5.5.

5.2 Data and model specification

5.2.1 Data source

Panel data is collected from the financial statements of individual commercial banks in Vietnam covering the years 2005–2012, including their balance sheets and income reports. Other relevant information, including the structure of bank equity, new bank entries and bank mergers, is collected from the annual reports of the SBV, the SBV official website and reports of the NFSC. In addition, working papers from academic institutions such as the ASH Institute for Democratic Governance and Innovation (Harvard Kennedy School) and development reports from international financial organisations, such as the World Bank and the International Monetary Fund, are also used as useful sources of data on equity owned by foreigners and macroeconomic indicators including the inflation rate and exchange rate.

As mentioned in Section 2.3, only data from 2005 onward ensures homogeneity because of the first implementation of regulations on loan classification and loan-loss provisioning. The studied period covers the pre- and post-WTO era to observe the impact of policy changes, stipulated as part of Vietnam's entry to the WTO, on bank efficiency. With a two-digit inflation rate (about 11-12%), the balance sheets of banks significantly deteriorated during the period 2005–2012. Hence, the data is also converted into real terms.

5.2.2 Sample

As mentioned in Chapter 2 there are four types of banks in Vietnam: state-owned commercial banks (SOCBs), joint stock domestic banks (JSBs), joint venture banks (JVBs) and foreign banks (FBs) (see Table 5.1). Most of the SOCBs are privatised but are predominantly owned by the state with the SBV being the representative entity. Foreign investors are allowed to take part in the privatisation process although they are limited by the maximal equity proportion that can be owned (30%). This mechanism ensures the Vietnamese government maintains control over these public banks. JVBs are established by a SOCB with one or more foreign counterparts. JSBs are established by stock joining from individuals, private companies and SOEs, or even SOCBs and other JSBs. As with SOCBs, JSBs can call for overseas investments. From April 2007, foreign investors can establish 100% foreign invested banks in Vietnam.

Table 5.1: The equity structure of banks according to ownership

Types of banks	Types of ownership		
	State ownership	Private ownership	Foreign ownership
SOCBs	(+)50%	(-)50%	(-)30%
JSBs	0%	(+)70%	(-)30%
JVBs	0%	(-)50%	(+)50%
FBs	0%	0%	100%

Note: the sign "(+)" means "at least equal to" and the sign "(-)" means "maximum equal to".

Source: Based on the Vietnamese law on credit institutions issued in 2010 by the National Assembly of Vietnam, pages 5-6, downloaded from the website of the Vietnam Ministry of Justice, http://moj.gov.vn/vbpq/Lists/Vn%20bn%20php%20lut/View_Detail.aspx?ItemID=25814

Table 5.2 reports on the number of banks categorised by ownership type. The number of SOCBs was stable over the study period at five, while in the case of JSBs it changed

with new bank entries and bank mergers. There was no significant change for JVBs during this period. FBs started operating in Vietnam from 2009 and subsequent to this their number remained stable until 2012. In this study the annual data of banks is pooled together and in this way a bank-year panel data consisting of 232 observations is generated.

Table 5.2: Number of banks by ownership category

	2005	2006	2007	2008	2009	2010	2011	2012
State-Owned Commercial Banks	5(5)	5(5)	5(5)	5(5)	5(5)	5(5)	5(5)	5(5)
Joint Stock Banks	33(11)	34(14)	33(19)	36(24)	37(25)	37(25)	37(25)	34(24)
Joint Venture Banks	4(1)	5(1)	5(2)	5(2)	5(2)	4(2)	4(3)	4(3)
Foreign Banks	0	0	0	0	5(1)	5(2)	5(3)	5(3)
Total	42(17)	44(20)	43(26)	46(31)	52(33)	51(34)	51(36)	48(35)

Note: the numbers in brackets are the number of banks used in this study.

Source: State Bank of Vietnam, annual reports from 2005 to 2012

Table 5.3 shows the market share of total bank assets by ownership type in Vietnam during the period 2005–2012. SOCBs dominated the banking system; however, the market share of this bank type sharply decreased from approximately 85% of the total sample in 2005 to about 52% in 2012. This period also witnessed a dramatic growth in JSBs from about 15% of total bank assets in 2005 to 38% in 2012. Domestic banks, consisting of SOCBs and JSBs, together make up the bulk of bank market assets, equivalent to slightly above 90% in 2012. JVBs and FBs with foreign-majority ownership contributed to less than 10% of total bank assets. This is due to the government and SBV's implementation of discriminatory policies which constrained

the development of JVBs and FBs, especially in the pre-WTO entry period. This situation improved after WTO accession but full equitable treatment of foreign investors was only implemented from 2011.

Table 5.3: Market share of assets by ownership

	2005	2006	2007	2008	2009	2010	2011	2012	Total
State-owned commercial banks	0.8475	0.7788	0.6538	0.6481	0.5788	0.5090	0.4848	0.5161	0.6271
Joint stock banks	0.1469	0.2153	0.3052	0.3096	0.3595	0.4038	0.4196	0.3840	0.3180
JSB transformed from rural banks	0	0	0.0330	0.0347	0.0524	0.0612	0.0659	0.0672	0.0393
Joint-venture banks	0.0056	0.0059	0.0080	0.0076	0.0068	0.0083	0.0096	0.0088	0.0076
Foreign banks	0	0	0	0	0.0025	0.0177	0.0201	0.0239	0.0080

Source: Calculated by the author using data obtained from financial statements and income reports of banks

5.2.3 Input/output specification in the DEA model

It is widely accepted that, despite substantial research efforts, there is a lack of agreement in identifying the relevant outputs and inputs to be used for a DEA analysis of banking sector efficiency (Kenjegalieva *et al*., 2009). According to Bergendhal (1998), commercial banks target five basic goals: profit maximisation, risk management, service provision, intermediation and utility provision to customers. Grigorian and Manole (2006) simplify these goals by pooling them into two functions: a profit maximisation function which incorporates the first two goals (profit maximisation and risk management) and a service provision function (combining service provision, intermediation and utility provision). Das and Ghosh (2006) summarise related studies and propose three basic approaches to banking inputs and outputs. The first is the *production approach* which considers banks as providers of services to customers. The

second is the *intermediation approach* in which banks are viewed as intermediating funds between savers and investors. The last approach is the *operating approach* that sees banks as profit-earning entities.

In the context of Vietnam's emerging market economy where the capital market is still shallow, the banking sector has been playing a key role as the main source of funding for both businesses and households. Thus, the intermediation approach is a reasonable and logical choice for this study and this is chosen as this study's main focus.

In the post-WTO period, banks experienced a significant increase in their capital, assets and scope of operations. Banks have opened many new branches in cities and provinces; accordingly, they have recruited more staff and built new offices. As a result, labour expenditure and fixed assets have become important inputs. One crucial characteristic of the Vietnamese banking sector is the high level of cash transactions in the economy, so more branches would lead to more mobilised deposits[63]. The development of a stock market in the post-WTO period has generated new channels for banks to invest their money other than the traditional channel of loans. New laws for commercial banks issued in 2006 permitting banks to widen their activities to include insurance, gold trading, stock trading and housing services has stimulated banks to increase their investments. Consequently, there has been a shift from the "loans and advances" item to "trading securities" and "investments" items (or other non-traditional assets) in banks' balance sheets. Therefore, under the intermediation approach, this

[63]In the literature, there is controversy relating to classifying deposits as an input or an output (Berger and Humphrey, 1997; Das and Ghosh, 2006). Deposits can be treated as inputs because "they are paid for in part by interest payments and the funds raised provide institutions with the raw material of investible funds" (Berger and Humphrey, 1997, page 198). Therefore, considering deposits as an input is appropriate under the intermediation approach. On the other hand, deposits are related to liquidity, safekeeping and payment services provided to depositors. Thus, deposits also have an output character (Berger and Humphrey, 1997). In this case, deposits can be considered as an output under the production approach.

study uses three inputs - labour expenses, fixed assets and deposits - while outputs are total loans and other earning assets.

In addition to the intermediation approach the operating approach is generally important in measuring bank efficiency due to the ultimate objective of banks – profit. Hence, this approach is also used in this study with the aim of providing an insight into the profit-making performance of banks. There is a consensus in selecting the variables for this approach: interest expenses and non-interest expenses are inputs, and interest income and non-interest income are outputs (Ataullah *et al*., 2004; Yao *et al*., 2007; Sturm and Williams, 2004; Jiang *et al*., 2009).

Table 5.4 statistically describes inputs and outputs using the minimum and maximum values, and mean and standard deviation. As can be seen in Table 5.4, the period 2005–2012 witnessed substantial data volatility. For example, the mean value of labour expenditure by banks surged from USD 16,962,208 in 2005 to USD 38,187,814 in 2012. This significantly increasing trend can be explained by the fact that the Vietnamese banking sector experienced rapid growth, especially after accession to the WTO in 2007. The country's loose and expansionary monetary policy, which had been in force for a long period of time, was simultaneously intensified by considerable capital inflows from overseas[64]. Moreover, a number of rural banks were allowed by the SBV to transform into urban banks. Before the transformation process these rural banks were very small and mostly focused their operations on lending to SMEs and farmers in remote areas.

[64] To keep the Vietnamese dong from appreciating relative to foreign currency the SBV bought foreign cash inflows. It injected dong into the economy which led to considerable excess liquidity in the banking system.

Table 5.4: A statistical description of inputs and outputs (in USD '000)

	Intermediation approach					Operating approach			
	Inputs			Outputs		Inputs		Outputs	
	Labour expense	Fixed assets	Deposits	Total loans	Other earning assets	Interest expenses	Non-interest expenses	Interest income	Non-interest income
2005									
Min	472	889	86,471	78,557	4,971	7849	1,020	11,066	434
Mean	16,962	27,285	2,158,788	1,699,346	310,367	99,964	46,031	175,391	21,689
Max	128,862	160,830	10,344,649	10,439,365	1,514,331	584,910	330,197	1,078,029	117,283
SD	32,252	41,260	3,217,455	2,863,038	456,035	157,612	84,622	286,564	34,140
2006									
Min	906	1,930	185,941	120,993	7,426	8,482	1,434	15,952	773
Mean	17,464	26,780	2,372,667	1,625,835	343,388	124,340	45,425	195,472	23,939
Max	136,788	119,547	12,449,253	10,804,420	1,886,676	778,110	345,561	1,317,765	120,058
SD	32,563	33,499	3,565,868	2,760,620	518,803	201,568	82,851	327,006	33,388
2007									
Min	882	728	77,326	70,939	110	4,787	1,337	8,997	92
Mean	21,112	23,984	2,414,387	1,686,255	448,987	124,607	43,064	196,027	29,441
Max	229,445	133,624	14,677,419	13,106,006	2,214,939	899,388	429,729	1,524,802	156,153
SD	47,085	31,783	3,582,181	2,953,540	668,442	211,234	88,138	343,956	42,747
2008									
Min	696	736	63,018	45,164	140	3,506	1,960	8,251	820
Mean	22,437	65,899	1,993,125	1,392,298	381,562	168,640	44,306	238,837	28,898
Max	223,748	1,221,472	14,873,673	12,903,348	1,939,929	1,338,582	435,826	1,970,727	250,143
SD	46,105	217,415	3,319,914	2,721,690	612,580	278,357	87,806	410,508	52,001
2009									
Min	1,123	659	59,101	73,609	250	139	847	1,620	121
Mean	25,247	29,090	2,267,800	1,719,343	367,952	134,503	48,322	203,192	35,035
Max	201,686	182,777	16,434,509	15,222,658	1,693,497	1,305,016	436,150	1,777,177	281,047
SD	45,812	40,207	3,471,632	3,141,105	516,165	249,220	86,022	354,527	61,191
2010									
Min	1,253	1,026	135,467	92,198	420	7,884	3,074	13,948	948
Mean	29,184	33,344	2,878,871	1,962,458	542,675	185,521	59,410	274,059	37,416
Max	248,328	195,099	15,770,193	15,544,701	2,365,860	1,407,692	481,616	2,027,658	220,755
SD	51,243	42,393	3,802,658	3,323,996	584,948	285,361	98,524	420,337	55,839
2011									
Min	1,587	873	24,128	16,412	662	970	3,929	9,208	750
Mean	33,816	33,443	2,707,653	1,852,551	456,248	254,230	67,681	367,049	27,599
Max	304,669	174,999	14,152,298	14,167,712	2,232,099	1,571,890	569,566	2,400,203	181,478
SD	57,957	40,182	3541761	3,178,886	522,773	347,594	112,298	521,512	45,300
2012									
Min	1,504	605	45,726	51,977	758	2,247	3,891	10,250	1,020
Mean	38,188	37,568	2,775,906	2,086,002	507,850	229,123	54,050	288,301	24,350
Max	328,012	153,078	13,505,858	13,567,112	2,415,730	1,330,244	288,202	1,466,945	148,059
SD	61,713	46,909	3,740,133	3,298,030	640,115	304,977	63,275	348,385	36,174
2005-12									
Min	472	605	24,128	16,412	110	139	847	1,620	92
Mean	26,989	35,683	2,483,038	1,774,023	432,927	174,878	52,272	253,101	29,236
Max	328,012	1,221,472	16,434,509	15,544,701	2,415,730	1,571,890	569,566	2,400,203	281,047
SD	49,598	87,555	3,517,096	3,036,787	571,518	273,474	88,806	393,261	47,057

Note: The figures presented are discounted by the inflation rate for the benchmark year 2005, and converted to US dollars using the exchange rate between the Vietnamese dong and USD on 31/12/2015.

Source: Calculated by the author using data obtained from financial statements and income reports of banks

5.2.4 Specification of the regression model

Once technical efficiency scores have been measured it is then important to identify the possible impact of environmental variables on bank performance through regression analysis. It is apparent that the efficiency score is the dependent variable. However, defining the independent variables is more complicated and depends on the specific nature of the study. In this study, environmental variables are classified into three categories: 1) bank-specific variables; 2) the time trend variable; and 3) variables indicating new policies that might impact on the banking sector. It is worth noting that each variable will appear in the meta-frontier DEA model that pools all bank groups (state-owned, private domestic and foreign/joint venture bank groups) and the group-frontier DEA model that includes banks of a specific group.

5.2.4.1 Bank-specific variables

Loan to asset ratio (LA)

During the period 2005–2012 Vietnam experienced a credit boom with an average annual credit growth rate of 35% (in nominal terms). This lending generates traditional assets including loans and advances and, in order to understand how this activity impacts upon bank efficiency, the loan to asset ratio is employed following on from the works of Hasan and Marton (2003), Havrylchyk (2006), Yildirim and Philoppatos (2007) and Chortareas *et al*. (2013).

Equity to asset ratio (EA)

The equity to asset ratio (EA) is used as a proxy for financial soundness (Fries and Taci, 2005; Grigorian and Manole, 2006; Kumbhakar and Wang, 2007; Jiang *et al*., 2009). A higher ratio relates to stronger capacity to protect banks against risks that could lead to an equity loss.

Return on assets (ROA)

Return on assets (ROA) is included in the model as a proxy for the profitability of banks (Das and Ghosh, 2006; Hermes and Nhung, 2010; Glass *et al*., 2014). A positive association between the profitability of banks and their efficiency is assumed.[65]

Time trend (T)

To control for the effect of time a time trend variable (T) is introduced which takes the value 1 for 2005, 2 for 2006 and so on to capture the evolving nature of efficiency. The time variable and its effect on bank efficiency have been investigated in the literature. For example, Williams and Nguyen (2005) utilise a time variable when examining the impact of bank governance on bank performance in the context of Southeast Asian countries encompassing the pre- and post-EAFC periods. Lensink *et al*. (2008) employ a time variable in SFA models when investigating whether the efficiency of foreign banks depended on the institutional quality of the host and home country.[66]

[65]ROE was also considered but ROA provided more significant results. Both ROE and ROA are regularly used in the literature.

[66]When adding a dummy variable capturing the impact of WTO membership the model runs badly and this is the result of co-linearity between the WTO dummy and the other dummies that proxy for new policy reforms adapted after the WTO event. As an alternative, the Li test and Simar and Zelenyuk tests are used to investigate the difference of bank performance between the pre- and post-WTO entry periods (see Section 5.3).

5.2.4.2 Policy-change related variables

The following variables are chosen to show the association between Vietnam's policy changes in the context of the banking sector and banks' performance in the post-WTO period.

FSI: dummy variable for foreign strategic involvement in domestic banks

Foreign investors can become shareholders of SOCBs and JSBs by purchasing their equity. However, the proportion of equity sold to foreign investors cannot exceed 30% of the total. To measure the impact of foreign strategic involvement, a dummy variable, FSI, is utilised to indicate banks with foreign involvement, following the approach of Hasan and Marton (2003) and Bonin *et al.* (2005a, 2005b). From a Vietnamese perspective, a positive relationship between foreign involvement and domestic bank performance is also assumed due to the advantages of overseas investors, for example access to advanced banking technology or stronger financial capabilities.

P: dummy variable for equitised SOCBs

In the post-WTO period it was planned that SOCBs would be privatised but this process had to ensure that the government continued to hold a dominant portion of banks' capital. A dummy variable, P, is used for those SOCBs which were partially privatised and zero for those not involved in this process. Following agent-principal theory, state ownership can negatively influence the performance of banks in terms of profit maximising or providing intermediate services and conversely state-owned banks become more efficient after being privatised (Shleifer and Vishny, 1997; Altunbas *et al.*, 2001; La Porta *et al*., 2002). This is because the participation of private shareholders in parallel with the state makes SOCBs more accountable and requires much stronger

commercial-based incentives. The SOCBs' model of management changes from an administrative unit, in which a director assigned by the government plays the role of both manager and state-owner representative, into a modern corporation with the separation of the decision making unit (board of directors) and ownership (shareholders).

RU: dummy variable for JSBs transformed from rural to urban banks

A number of rural JSBs were permitted to transfer to urban banks. It was expected that these transformed banks would increase their scope of operation and consequently improve their efficiency; however, poor management and weak capital capability represented substantial challenges in comparison with other JSBs (WB, 2012; VELP, 2012). The dummy variable RU is employed to distinguish such transformed JSBs from others in the same group.

BG: dummy variable for JSBs with SOEs or private business groups being the shareholders

A number of SOEs and private business groups were allowed by the government to participate in the banking sector and become holding companies of JSBs. Subsequently, a complex relationship, so-called cross-ownership, between these SOEs (non-bank business groups) and JSBs was established. Being major shareholders, SOEs can influence the decision making processes of these banks and channel bank credit to projects that are of relevance to them. Thus, cross-ownership can obstruct contestability and facilitate collusion between banks and SOEs/private business groups (Kraft *et al*., 2006). In this case it is assumed that cross-ownership can impact the efficiency of JSBs.

A dummy variable (BG) is included in the model indicating those JSBs that have at least 20% of their total equity owned by one or more SOEs.

Table 5.5: A summary of the employed regression variables

Variable		Description
Policy change variables		
• Selected for business group participation in JSBs	BG	Dummy indicating JSBs that have experienced equity participation by SOEs/private business groups.
• Selected for SOCB equitisation	P	Dummy indicating SOCBs that have experienced equitisation between 2005 and 2012.
• Banks with foreign capital participation	FSI	Dummy indicating a bank that sold a minor proportion of its equity (not exceeding 30%) to foreign investors.
• Rural-urban transformed banks	RU	Dummy indicating JSBs which transformed from rural to urban banks.
Bank specific variables		
• Loans to assets ratio	LA	The ratio of loans to assets measures the risk preference of a bank.
• Equity to assets ratio	EA	The ratio of equity to assets measures the financial soundness of a bank.
• ROA	ROA	Return on assets measures the profitability of a bank.
Time trend variable	T	Trend variables (2005=1, 2006=2, … , 2012=8).

Table 5.6: Statistical description of environmental and bank-specific variables

Indicators	Mean	SD	Min	Max
BGs	0.3491	0.4777	0	1.0000
P	0.1034	0.3052	0	1.0000
FSI	0.2284	0.4207	0	1.0000
RU	02112	0.4090	0	1.0000
LA	0.5213	0.1504	0.1293	0.9442
EA	0.4374	0.0998	0.0107	0.8006
ROA	0.0159	0.0104	0.0001	0.0769
T	5.0000	2.1622	1.0000	8.0000

Source: Author's calculation

5.3 A comparison of technical efficiency between the pre- and post-WTO periods

The total of 232 bank-year observations for the period from 2005 to 2012 are divided into two subsamples. There are 31 observations belonging to the pre-WTO subsample (2005–2006) and 195 observations for the post-WTO subsample (2007–2012). It is important to measure and compare bank performance between the pre- and post-WTO era because this can assist policy makers to identify the impact of reform measures in the post-WTO period on bank operations. To compare bank performance within and across these periods, the method for aggregating technical efficiency suggested by Simar and Zelenyuk (2007) is used, allowing for comparison of the efficiency of two groups by taking into consideration the relative importance of individual banks based on their size in each group, unlike conventional approaches which give equal importance (weighting) to all banks. The Simar and Zelenyuk (2007) method is based on bootstrap techniques that overcome the biased nature of DEA estimates. This method allows

recognising the efficiency levels of the pre- and post-WTO periods and testing the efficiency difference between the two periods. The results are provided in Table 5.7. Agg.Eff. and M.Eff. represent the aggregate and mean efficiency of the banking sector in the 2005–2012 period respectively. The bootstrap values of Agg.Eff. and M.Eff. are found to be 1.2068 and 1.4604 under the intermediation approach and 1.1728 and 1.4187 under the operating approach (Table 5.7)[67]. These results reveal that:

1) the mean and aggregate efficiency models provide considerably different results. The aggregate efficiency values under both approaches are substantially smaller than the mean values and this confirms the impact of output size on the efficiency of groups; and

2) inefficiencies under both the intermediation and operating approaches are greater than unity and those under the intermediation approach are larger than those under the operating approach, indicating that there is room for Vietnamese banks to improve their technical efficiencies in terms of both providing intermediation services and in achieving the profit maximising standard.

On average, using point estimates of efficiency, banks can increase the volume of intermediation services by 20.68%[68] using the bias-corrected aggregate measure or 46.04% in terms of the bias-corrected mean criterion. Using confidence intervals of efficiency, at a significance level of 5%, intermediation activities can be extended further than the contemporary volume at a pace between 15.83% and 23.95% in terms

[67] The Farrell output-oriented measure of technical efficiency is utilised; thus, the higher value scores mean that the related banks are less efficient.

[68] This increasing rate is compared with the contemporary level of output. Another way in which to interpret efficiency scores is by transforming the Farrell (1957) type of efficiency as used in this thesis to the Shephard (1970) type of efficiency. Accordingly, the latter type is equal to the reciprocal form of the former type. For example, if the score is 1.2068 using the Farrell type of efficiency it would be 0.8286 when applying the Shephard type of efficiency and this figure means that the potential output of banks can increase by 17.14% with the same level of inputs. The Shephard type way of presenting efficiency scores can be applied for any similar cases.

of the aggregate measure or between 37.72% and 52.69% using the mean measure. Similarly, interest and non-interest incomes, at a significance level of 5%, can increase between 12.80% and 20.31% or between 33.34% and 48.86% if the bootstrap aggregate and mean criterions are used respectively.

The AER (aggregate efficiency ratio), presented in Table 5.7, is the ratio of the pre-WTO to the post-WTO aggregate efficiency score. Table 5.7 shows that at the 10% and 5% levels of significance, the confidence interval (CI) of AER includes unity (the CIs of the pre- and post-WTO periods overlap) under both the intermediation and operating approaches and thus the hypothesis H_0 ($\overline{\delta^A} = \overline{\delta^Z}$)[69], that the efficiency scores for the pre- and post-WTO era are the same in terms of both providing intermediation services and also maximising profit, cannot be rejected. The same conclusion can be made using the MER (mean efficiency ratio), the ratio of pre-WTO to post-WTO mean efficiency scores (see Table 5.7), on the equality of efficiency scores in the pre- and post-WTO eras regardless of the input/output approach employed.

In theory, financial liberalisation is expected to improve bank efficiency by eliminating government control and encouraging the rule of free and fair markets that, in turn, pressure banks to improve the overall quality of their management and risk management and to allocate their scarce financial resources more efficiently (Lensink *et al*., 2008). In the literature, empirical studies using single-country data have provided mixed results, indicating that the impact of financial liberalisation can have both positive and negative effects on bank performance (Hermes and Nhung, 2010). Negative and unexpected outcomes can be explained by macroeconomic instabilities or even financial crises occurring during and/or after the liberalisation programs that distort the incentive

[69] For more detail on this hypothesis see Subsection 4.3.2.

structure of the banks and make the allocation of resources to achieve efficiency a more difficult task (Denizer *et al*., 2007). The equality of Vietnamese bank efficiency scores in the pre- and post-WTO period cannot be rejected, implying that no significant improvement in bank performance has occurred, contradicting the previously mentioned empirical literature. In addition, this result is unique when compared to previous studies which demonstrate either a positive (e.g, Maudos *et al*., 2007; Berger *et al*., 2009) or a negative impact (e.g, Hao *et al*., 2001; Denizer *et al*., 2007), but in this case the impact is insignificant. From 2007 onward, Vietnam has conducted a number of reform measures and the impact of these on bank efficiency has again been both positive and negative.[70] It is assumed that the influence of positive measures is balanced by the negative measures resulting in an overall insignificant change to efficiency levels in the post-WTO period.

[70] The studied period (2005–2012) also witnessed the GFC but the impact of this crisis on Vietnamese bank efficiency was insignificant (see Nguyen *et al*., 2014). The Simar and Zelenyuk (2007) and Li (1996) tests can also be utilised to examine the impact of the GFC on Vietnamese bank performance. The period is divided into two sub-periods, 2005–2007 and 2008–2012. The results are the same as those of Nguyen *et al*., pointing to the insignificant impact of the GFC. For more detail see Appendix A.

Table 5.7: A comparison of technical efficiency between the pre- and post-WTO periods

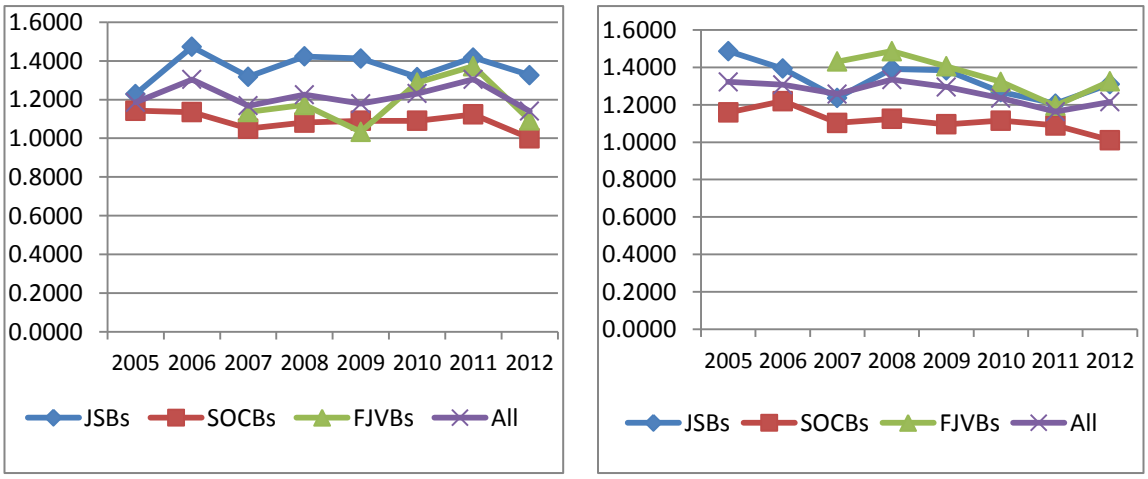
	Intermediation Approach							Operating Approach						
	DEA Estimation	Standard Error	Bias Correction Estimation	Confidence Interval Bounds				DEA Estimation	Standard Error	Bias Correction Estimation	Confidence Interval Bounds			
				90%		95%					90%		95%	
Agg.Eff. Pre-WTO	1.1326	0.0508	1.1889	1.0794	1.2472	1.0588	1.2521	1.1528	0.0500	1.2173	1.1171	1.2769	1.0912	1.2819
Agg.Eff. Post-WTO	1.1356	0.0238	1.2076	1.1629	1.2401	1.1506	1.2443	1.1097	0.0215	1.1661	1.1257	1.1948	1.1140	1.1977
Agg.Eff.	1.1352	0.0210	1.2068	1.1674	1.2362	1.1583	1.2395	1.1149	0.0199	1.1728	1.1373	1.2003	1.1280	1.2031
M.Eff. Pre-WTO	1.2851	0.0771	1.4144	1.2742	1.5125	1.2354	1.5260	1.3447	0.0638	1.4998	1.3895	1.5978	1.3635	1.6109
M.Eff. Post-WTO	1.3074	0.0403	1.4701	1.3988	1.5312	1.3815	1.5402	1.2736	0.0410	1.4075	1.3356	1.4679	1.3196	1.4743
M.Eff.	1.3038	0.0384	1.4604	1.3917	1.5180	1.3772	1.5269	1.2850	0.0403	1.4187	1.3468	1.4801	1.3334	1.4886
AER	0.9973	0.0528	0.9823	0.8786	1.0525	0.8502	1.0630	1.0389	0.0501	1.0441	0.9494	1.1101	0.9143	1.1202
MER	0.9716	0.0703	0.9328	0.8061	1.0291	0.7761	1.0428	1.0567	0.0518	1.0693	0.9768	1.1462	0.9554	1.1588

Notes: Agg.Eff. Pre-WTO and Agg.Eff. Post-WTOarethe aggregate efficiency scores of banks in the pre- and post-WTO era respectively. Agg.Eff is the aggregate efficiency score of the whole sample (both pre- and post-WTO era). M.Eff. Pre-WTO and M.Eff. Post-WTOare mean efficiency scores of banks in the pre- and post-WTO era respectively. M.Eff is the mean efficiency scores for the whole sample. AER is the ratio of the aggregate efficiency score of banks pre-WTO to the post-WTO period. MER is the ratio of the mean efficiency score of banks pre-WTO to that post-WTO. For each degree of significance, there are two columns indicating the upper and lower bounds of the estimators.

Figure 5.1below demonstrates how the average efficiency of each group and the whole banking industry has changed over time. Panel A and B present the movement of group and industry efficiency under the intermediation and operating approach, respectively. Using the intermediation approach the chart does not show a clear increasing/decreasing trend of group efficiency and it seems that there is no significant change during the 2005−2012 period. This result is also in line with results obtained using the Simar and Zelenyuk (2007) test in that there is no change of efficiency between the pre- and post-WTO entry periods. Under the operating approach efficiency scores of groups tend to slightly decrease, demonstrating a fact that the banking sector may perform better (see Panel B, Figure 5.1).

Figure 5.1: Trend lines of group efficiency

Intermediation approach **Operating approach**



Panel A Panel B

The differences and similarities of bank efficiency between the two periods is further investigated by employing the Li test which allows testing of how different bank groups access the production frontier. Table 5.8 presents the Li (1996) test results on efficiency densities of the Vietnamese banks. Under both the intermediation and operating approaches the *p*-values of the two approaches are 0.4075 and 0.6425 respectively, suggesting that the null hypothesis of equality between the two distribution functions cannot be rejected. The results imply that the capability of banks to access optimal performance has generally not been different in the pre- and post-WTO accession periods. Therefore, one may argue that reform measures implemented from 2007 onwards (the post-WTO period), including privatisation of SOCBs and allowing business groups and foreign investors to take part in the banking sector, have not brought about an obvious change in the capability of banks to access the production frontier (Vo and Nguyen, 2009; Pincus, 2009).

Table 5.8: Li test on the technical efficiency density of banks in the pre- versus post-WTO era

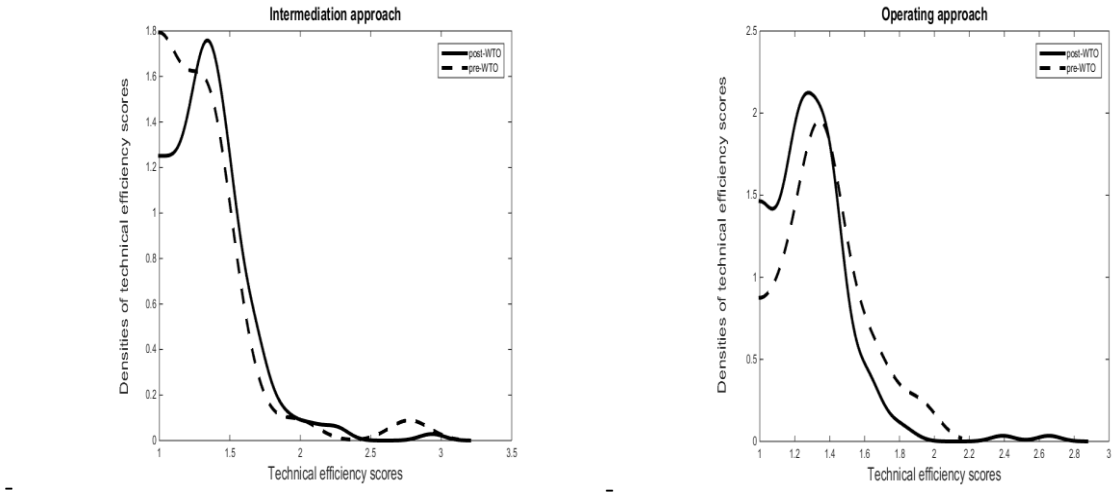
	H_0 (f is density)	Li test [*p*-value]	Decision on H_0
Intermediation approach	f1(pre-WTO) = f1(post-WTO)	-0.7454 [0.4075]	Do not reject H_0
Operating approach	f2(pre-WTO) = f2(post-WTO)	-0.4756 [0.6425]	Do not reject H_0

Note: H_0: densities of the two bank groups are equal

Figure 5.2 simulates the efficiency densities of bank groups in the two periods using the two input/output approaches (intermediation in Panel 1 and operating in Panel 2). The horizontal axis presents the technical efficiency scores of individual banks where efficient banks obtain unity while inefficient banks obtain values larger than unity. The vertical axis presents the densities of technical efficiency scores of individual banks.

The density curves for pre-WTO entry efficiency and post-WTO entry efficiency are shown in Figure 5.2. Under these two approaches the shape of the two curves is similar.

Figure 5.2: Kernel estimation densities of individual efficiency scores



Panel 1 Panel 2

Note: the dashed line represents the pre-WTO efficiency scores and the solid line represents the post-WTO efficiency scores.

These findings on the statistical similarity of bank performance during the pre- and post-WTO periods do not indicate either a positive or negative change in relation to bank efficiency. However, bank groups classified by ownership criterion may have reacted differently to the reform measures. Therefore, in the next section the impact of reform measures as well as bank-specific variables on bank efficiency are further investigated.

5.4 A comparison of aggregate technical efficiency amongst bank groups in accordance with ownership

5.4.1 Simar and Zelenyuk (2007) test on the performance of bank groups

To compare bank efficiency across the three previously mentioned groups, the whole sample of 232 bank-year observations is divided into three subsamples: 40 observations of the total are public banks, 167 observations are private banks, and the remainder (25 observations) are foreign and joint-venture banks. These bank groups are organised into three pairs (SOCBs and JSBs; SOCBs and FJVBs; JSBs and FJVBs). The production frontier of the banking sector has been estimated and, accordingly, the ratios of aggregate and mean technical efficiency of each of the two groups are measured and compared using the test outlined in Simar and Zelenyuk (2007).

Table 5.9 shows that the ratios of aggregate and mean technical efficiency of JSBs to SOCBs are respectively 1.3471 and 1.3482 under the intermediation approach while they are 1.2313 and 1.2483 under the operating approach. All these ratios are larger than unity and significant at 1%. As the aggregate and mean technical efficiency scores of the JSB group are larger than those of the SOCBs, it can be concluded that the JSB group is less efficient than the SOCB group. The ratios of aggregate and mean technical efficiency of SOCBs over FJVBs are 0.8419 (significant at 5%) and 0.8750 (significant at 5%) under the intermediation approach and 0.9186 (insignificant) and 0.7931 (significant at 1%) under the operating approach. The ratios, in this case, are all under unity and demonstrate that the efficiency scores of the SOCBs are smaller than those of the FJVBs. This supports SOCBs outperforming their foreign rivals. Therefore, one can conclude that there is evidence that the SOCB group is the most efficient in comparison to JSBs and FJVBs under both input/output options.

This result is contrary to agent-principle theory which usually indicates the outperformance of private banks over publicly owned banks. Due to the agency problem arising from the separation of ownership and control, it is difficult to identify the actual

owners of state-owned banks, nominally the tax payers. It is the government, rather than the tax payers, that usually plays the role of owner of state-owned banks, and it controls and orients the objectives of these banks to serve its policies rather than to benefit tax payers. This result contradicts mainstream empirical research which has supported this theory in investigating both single and cross-country datasets and also considering various input/output mixes using the intermediation, operating, production and value-added approaches (Bonin *et al*., 2005a; 2005b; Fries and Taci, 2005; Berger *et al*., 2009; Cornett *et al*., 2010; Fang *et al*., 2010). It is in line however with Kraft *et al*. (2006),Denizer *et al*. (2007) and Karas *et al*. (2010)with similar analyses conducted in other transition and newly emerging market economies, in which they conclude that deficiencies in the business environment are the cause. They identify several issues. First, state owned banks obtain guarantees of solvency from the government and, therefore, they can make loans and receive deposits more easily than their private rivals. Additionally, private banks struggle with lack of access to capital, have poor governance and risk management, and have to deal with cross-ownership by industrial groups which increases the possibility of insider trading, resulting in a deterioration of assets. The business environment in which Vietnamese banks operate, as mentioned in Chapter 2, is similar. State-owned banks are majority owned by the central bank; hence, there is guaranteed solvency and privileges from the State such as access to capital. In contrast, low transparency and a weak regulation and supervision framework have undermined the performance of domestic private banks in Vietnam. Cross-ownership is popular in most JSBs and their investments in real estate and stock markets have not been well controlled, resulting in a high NPL rate. Foreign banks, although allowed to operate in Vietnam from 2007 as a commitment to the WTO, nonetheless have only

been treated with the same rights as domestic banks from 2011. This discrimination explains the constraints foreign banks in Vietnam have faced in expanding their services and customer base and why they are revealed to be less efficient than SOCBs.

In the case of comparing JSBs with FJVBs, the ratios presenting the efficiency of JSBs over FJVBs, using both the mean and aggregate criterions, are significantly larger than unity under the intermediation approach. For example, at the 5% level of significance the ratio based on aggregate efficiency scores is 1.1447. These results indicate that the FJVB group is more efficient than the JSB group in terms of providing intermediation services. The result is similar when the operating approach is employed. While the ratio based on the aggregation method indicates an outperformance by the FJVBs over the JSBs, the ratio based on the mean criterion is insignificantly smaller than unity at 0.9983 showing that there is, in fact, no major discrepancy between the two groups.

Table 5.9: Simar and Zelenyuk (2007) tests on the differences in efficiency between SOCBs, JSBs and FJVBs

	Intermediation approach							Operating approach						
	Bias-corrected estimation	Confidence interval						Bias-corrected estimation	Confidence interval					
		90%		95%		99%			90%		95%		99%	
JSBs versus SOCBs														
AER JSBs/SOCBs	***1.3471	1.2686	1.4130	1.2500	1.4246	1.2143	1.4426	***1.2313	1.1639	1.2869	1.1469	1.2937	1.1185	1.3056
MER JSBs/SOCBs	***1.3482	1.2569	1.4320	1.2307	1.4479	1.1838	1.4825	***1.2438	1.1504	1.3270	1.1292	1.3448	1.0905	1.3623
JSBs versus FJVBs														
AER JSBs/FJVBs	**1.1447	1.0294	1.2820	1.0117	1.3160	0.9660	1.3585	**1.1333	1.0414	1.2434	1.0252	1.2649	0.9948	1.3058
MER JSBs/FJVBs	***1.1909	1.0803	1.2975	1.0603	1.3201	1.0163	1.3675	0.9983	0.8894	1.1071	0.8707	1.1297	0.8272	1.1745
SOCBs versus FJVBs														
AER SOCBs/FJVBs	**0.8419	0.7727	0.9537	0.7638	0.9738	0.7468	1.0126	0.9186	0.8603	1.0112	0.8538	1.0292	0.8379	1.0622
MER SOCBs/FJVBs	**0.8750	0.7933	0.9584	0.7790	0.9774	0.7393	1.0115	***0.7931	0.6878	0.9022	0.6676	0.9199	0.6327	0.9482

Notes: AER JSBs/SOCBs and MER JSBs/SOCBs are ratios of the aggregate and mean technical efficiency scores of JSBs over those of SOCBs respectively. The same logic can be used for the other pairs of bank groups. At each degree of significance there are two columns indicating the upper and lower bounds of the ratios. The ratios are significantly larger or smaller than unity at a significance degree if both its equivalent upper and lower bounds are larger or smaller than unity. The coefficients marked with ** or *** are significant at the 5% or 1% levels respectively.

It is worth noting that through ranking efficiency the relative performance of individual banks in a particular year can be compared in order to identify which are the most or least efficient. Table 5.10 below presents an efficiency ranking of Vietnamese banks in2012.Using the intermediation approach to inputs/outputs the state-owned and foreign owned bank groups are the most efficient. These include VCB (Joint Stock Commercial Bank for Foreign Trade of Vietnam), ICB (Vietnam Bank for Industry and Trade), BIDV (Bank for Investment and Development of Vietnam), Agribank (Vietnam Bank for Agriculture and Rural Development), HSBC (Hongkong and Shanghai Banking Corporation); HLB (Hong Leong Bank); Shinhan (Shinhan Commercial Bank); and VTB (Viet Thai Joint Venture Bank).The most inefficient banks are the JSBs, for example, SEA (Southeast Asia Commercial Joint Stock Bank). Under the operating approach the top ranked banks are a JSB (Southern Commercial Joint Stock Bank - PNA); two SOCBs (Bank for Investment and Development of Vietnam– BIDV and Vietnam Bank for Agriculture and Rural Development Bank - Agribank) and one foreign bank (Shinhan bank). The lowest ranked positions mostly belong to the private banks group. Specifically, of the five least performing banks, four belong to the JSB group while the remaining one is a joint venture bank.

Table 5.10: Efficiency Ranking of Vietnamese banks in 2012

Intermediation approach				Operating approach			
Rank	eff. Scores	Bank name	Bank type	Rank	eff. Scores	Bank name	Bank type
1	1.0000	VCB	SOCBs	1	1.0000	PNA	JSBs
1	1.0000	ICB	SOCBs	1	1.0000	BIDV	SOCBs
1	1.0000	BIDV	SOCBs	1	1.0000	Agribank	SOCBs
1	1.0000	Agribank	SOCBs	1	1.0000	Shinhan	FJVBs
1	1.0000	HSBC	FJVBs	2	1.0039	ICB	SOCBs
1	1.0000	HLB	FJVBs	3	1.0156	HSBC	FJVBs
1	1.0000	Shinhan	FJVBs	4	1.0396	VCB	SOCBs
1	1.0000	VTB	FJVBs	5	1.0894	MB	JSBs
2	1.0204	MB	JSBs	6	1.1957	ACB	JSBs
3	1.0449	MDB	JSBs	7	1.2015	SACB	JSBs
4	1.0807	TCB	JSBs	8	1.2028	SEA	JSBs
5	1.0921	MRB	JSBs	9	1.2282	LVB	JSBs
6	1.1095	VIB	JSBs	10	1.2284	Exim	JSBs
7	1.1231	VPB	JSBs	11	1.2726	SGB	JSBs
8	1.1887	HDB	JSBs	12	1.2775	KLB	JSBs
9	1.1959	PGB	JSBs	13	1.2802	EAB	JSBs
10	1.2258	EAB	JSBs	14	1.2925	TCB	JSBs
11	1.2567	BVB	JSBs	15	1.2961	IVB	FJVBs
12	1.2612	IVB	JSBs	16	1.3169	VIB	JSBs
13	1.2783	SGB	JSBs	17	1.3415	DAB	JSBs
14	1.2972	VID	FJVBs	18	1.3595	HLB	FJVBs
15	1.3059	SACB	JSBs	19	1.3636	ABB	JSBs
16	1.3389	LVB	JSBs	20	1.3729	PGB	JSBs
17	1.3478	ACB	JSBs	21	1.3743	VPB	JSBs
18	1.4158	MHB	JSBs	22	1.3861	SHB	JSBs
19	1.4287	WB	JSBs	23	1.3863	MDB	JSBs
20	1.4408	Exim	JSBs	24	1.3898	BVB	JSBs
21	1.4451	NVB	JSBs	25	1.4049	HDB	JSBs
22	1.4526	NAMA	JSBs	26	1.417	WB	JSBs
23	1.4624	SHB	JSBs	27	1.4284	VID	FJVBs
24	1.4657	DAB	JSBs	28	1.4405	MRB	JSBs
25	1.4931	PNA	JSBs	29	1.4437	MHB	JSBs
26	1.4953	KLB	JSBs	30	1.4567	NAMA	JSBs
27	1.6341	ABB	JSBs	31	1.5196	NVB	JSBs
28	1.9046	SEA	JSBs	32	1.8572	VTB	FJVBs

Notes: ABB: An Binh Commercial Joint Stock Bank; ACB: Asia Commercial Joint Stock Bank; Agribank: Vietnam Bank for Agriculture and Rural Development Bank; BIDV: Bank for Investment and Development of Vietnam; BVB: Bao Viet Commercial Joint Stock Bank; DAB: Dai A Commercial Joint Stock Bank; EAB: East Asia Commercial Joint Stock Bank; EXIM: Vietnam Export and Import Commercial Bank; HDB: Housing Development Commercial Joint Stock Bank; HLB: Hong Leong Bank; HSBC: Hongkong and Shanghai Banking Corporation; ICB: Vietnam Bank for Industry and Trade; IVB:

International Vietnam Bank; KLB: Kien Long Commercial Joint Stock Bank; LVB: Lien Viet Bank; MB: Military Commercial Joint Stock Bank; MDB: Mekong Development Bank; MHB: Mekong Housing Bank; MRB: The Maritime Commercial Joint Stock Bank; NAMA: Nam A Commercial Joint Stock Bank; NVB: Nam Viet Commercial Joint Stock Bank; PGB: Petrolimex Group Commercial Joint Stock Bank; PNA: Southern Commercial Joint Stock Bank; SACB: Saigon Thuong Tin Commercial Joint Stock Bank; SEA: Southeast Asia Commercial Joint Stock Bank; SGB: Saigon Commercial Bank; SHB: Saigon-Hanoi Commercial Joint Stock Bank; Shinhan: Shinhan Commercial Bank; TCB: Viet Nam Technological and Commercial Joint Stock Bank; VCB: Joint Stock Commercial Bank for Foreign Trade of Vietnam; VID: Vid Public Joint Venture Bank; VPB: Vietnam Prosperity Commercial Joint Stock Bank; VTB: Viet Thai Joint Venture Bank: VIB: Vietnam International Commercial Joint Stock Bank: WB: Western Commercial Joint Stock Bank.

5.4.2 Li test on the performance of bank groups

To provide another insight on the differences in bank group performance the Li (1996) test is used to investigate whether accessibility to the production frontier is divergent across bank groups. Table 5.10 presents Li test results on the three pairs of bank groups under both the intermediation and operating approaches.

The result for the first pair, being JSBs and SOCBs, shows that the two groups access the production frontier differently. The Li test statistics are 13.3329 and 14.0204 under the intermediation and operating approaches respectively. The *p*-value of both approaches are 0.0000 suggesting that the efficiency densities for the two groups are not equal. The same results are obtained for the JSB/FJVB pair. The *p*-value of Li statistics are 0.0020 and 0.0030 under the intermediation and operating approaches respectively, supporting an inequality of efficiency densities between the JSB and FJVB groups.

The above inequalities could have resulted from different responses and treatments in the business environment which could explain the disparity of the groups' accessibility to the production frontier. In the context of Vietnam, where transition to a market economy is still at a relatively early stage, a level playing field for private and state-owned banks has not been established. The State, by controlling and employing the banking sector as a means to achieve political outcomes, has given a lot of privileges to

the state-owned banks. In addition, the fact that the foreign cohort accesses the frontier differently again to their domestic counterparts can also be explained by the diversity of banking activities. The domestic banks mostly focus their activities on business lending while the foreign cohort diversifies their operations by providing a variety of services, for example, business and consumption lending, financial consulting and various types of international settlement.

The Li tests for the final pair (SOCB versus FJVB) provide inconsistent results. Under the intermediation approach accessibility to the frontier for foreign and joint venture banks is the same as that of state-owned banks (the *p*-value are 0.6345) (see Table 5.11). Under the operating approach the *p*-value is 0.0420; thus, the H_0 hypothesis is rejected at the 5% significance level highlighting the difference of capability to access the frontier in terms of maximising profit between the two groups.

Table 5.11: Li test on the technical efficiency density of bank groups

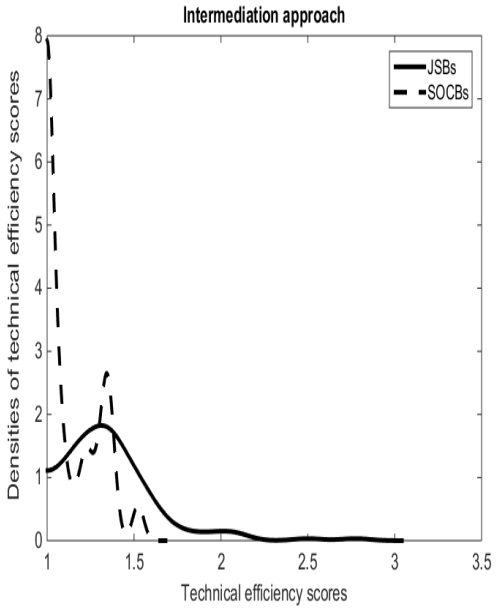
	H_0(f is density)	Li test	Decision on H_0
JSB and SOCB			
Intermediation approach	f1(JSB) = f1(SOCB)	13.3329[0.0000]	Reject H_0
Operating approach	f2(JSB) = f2(SOCB)	14.0204[0.0000]	Reject H_0
SOCB and FJVB			
Intermediation approach	f1(SOCB) = f1(FJVB)	0.2979[0.6345]	Do not reject Ho
Operating approach	f2(SOCB) = f2(FJVB)	1.1117[0.0420]	Reject Ho
JSB and FJVB			
Intermediation approach	f1(JSB) = f1(FJVB)	3.2348 [0.0020]	Reject Ho
Operating approach	f2(JSB) = f2(FJVB)	3.1730 [0.0030]	Reject Ho

Note: H_0: densities of the two bank groups are equal.

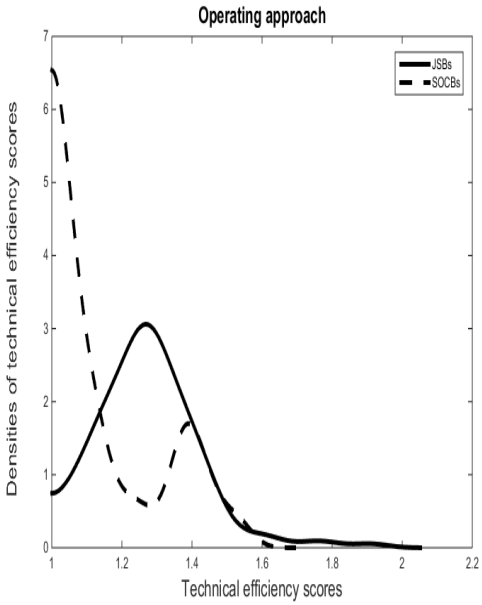
Figure 5.3 shows the Kernel estimation densities of individual efficiency scores of banks belonging to different groups under the intermediation and operating approaches. The three groups are organised into pairs: JSBs versus SOCBs (see panel A and B); SOCBs versus FJVBs (see panel C and D) and JSBs versus FJVBs (see panel E and F). Each panel is a Cartesian coordinate system with the horizontal axis presenting technical efficiency scores and the vertical axis presenting densities. The curve inside the panel, demonstrating possible coordinates of efficiency scores and densities, shows how the distribution of these scores vary. Observing all the panels, it is clear that the curves are asymptotic to the horizontal lines when the efficiency score increases.

Figure 5.3: Kernel estimation densities of individual efficiency scores

JSBs versus SOCBs

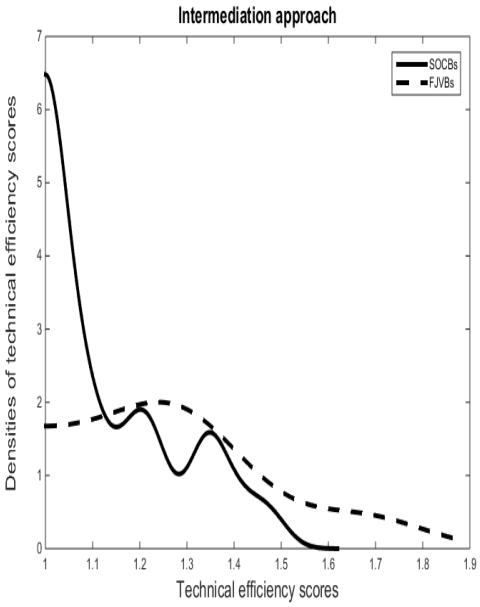


Panel A

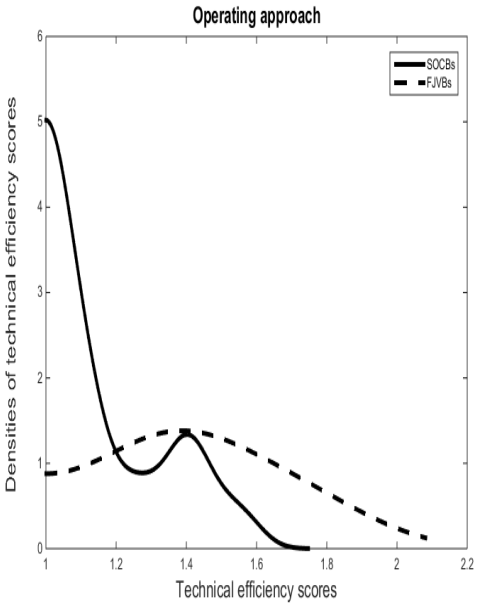


Panel B

SOCBs versus FJVBs

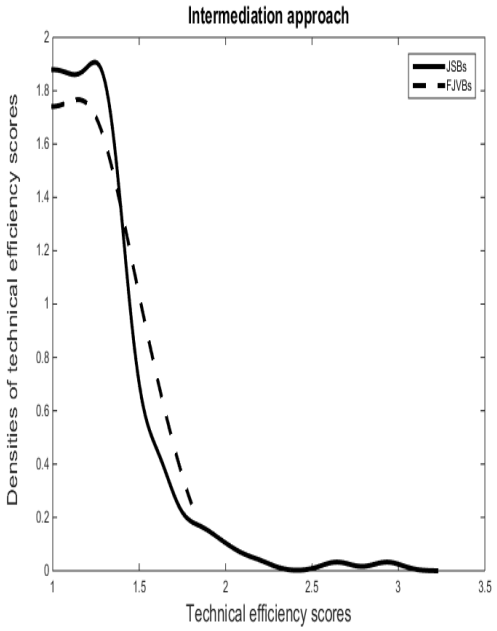


Panel C

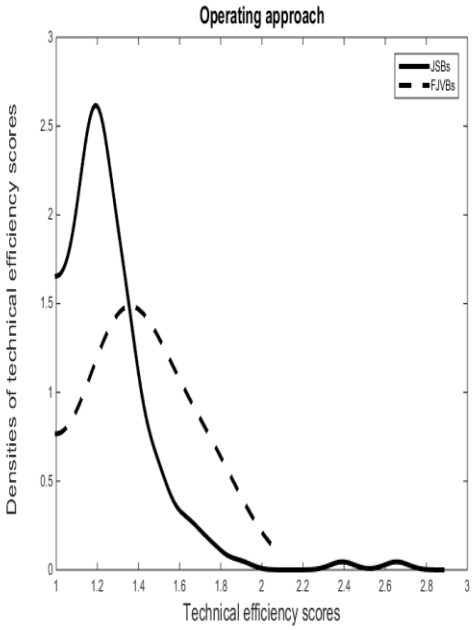


Panel D

JSBs versus FJVBs



Panel E



Panel F

5.5 Summary

The objective of this chapter has been to describe the data used in this study including the inputs, outputs and explanatory variables. The performance of Vietnamese banks under the impact of WTO accession in 2007 is analysed with a comparison of efficiency between the pre- and post-WTO periods. The study has relied on data from Vietnamese banks for the period 2005–2012 and a bootstrap variant of the DEA estimator has been used to estimate efficiency. By using bootstrap techniques this study overcomes the downward-biased nature of DEA estimates and the results obtained are consistent and unbiased. For the efficiency measurement and analysis Matlab software was utilised. Using the Li (1996) and Simar and Zelenyuk (2007) tests the results show that bank efficiency is similar between the pre- and post-WTO periods as is access to the meta-production frontier. These tests were also used to investigate the difference between

bank group performances and there is evidence to suggest that state-owned banks, under both input/output approaches, have performed the most efficiently, ahead of their foreign owned rivals, while domestic private banks are the least efficient when compared to the other two groups.

The next chapter will concentrate on investigating variations of bank efficiency under the assumption that technology sets utilised by different bank groups can diverge. Furthermore, the productivity of the banking sector will be examined.

Chapter 6: Analysis of Vietnamese bank efficiency and productivity

6.1 Introduction

This chapter investigates the impact of environmental variables on the technical efficiency of the Vietnamese banking sector and also includes an empirical analysis of the productivity changes in the Vietnamese banking sector during the post-WTO entry period. This chapter investigates the impact of financial reforms, bank characteristics and time trends on the performance of the Vietnamese banking sector under the assumption that different types of ownership can result in a divergence of technology sets utilised by different bank groups. By combining a meta-frontier analysis with double-bootstrap two-stage DEA the impact of environmental variables on bank efficiency across separate groups operating under different technology sets can be analysed. Accordingly, this chapter employs ownership as an *ex ante* rather than an *ex post* factor as used in all earlier studies that examined the influence of this environmental variable on bank efficiency. In addition, an analysis of productivity is conducted by using a variant of the conventional Malmquist index which is based on the concept of aggregate technical efficiency. The relative importance of individual banks (weighting) is accounted for in the index.

The structure of this chapter is as follows: Section 6.2 provides an analysis of the technology gap between each bank group frontier and the meta-frontier which is also the production frontier of the entire banking sector; an analysis of the impact of environmental variables on bank efficiency by a combination of the meta-frontier analysis approach and the double-bootstrap two-stage DEA method is presented in Section 6.3;productivity changes in the banking sector over the period 2007–2012 is

also measured by means of aggregate Malmquist indexes in Section 6.4; and lastly, a summary reviewing the chapter's contents is included in Section 6.5.

6.2 Technology gap analysis

Table 6.1 reveals that the production frontier of the JSB bank group is located furthest from the meta-frontier when compared with the other groups based on both basic and double-bootstrap two-stage DEA results and under the operating and intermediation input/output approaches. The evidence for this is that the mean and aggregate MTRs[71] are relatively smaller than those of the SOCB and FJVB groups. For instance, under the operating approach the JSB group's mean MTR estimated using the bias-corrected technical efficiency scores (0.9000) is smaller than the SOCB and FJVB groups (0.9476 and 0.9585). It is obvious that it is more difficult for the JSB group, as compared to the other bank groups, to reach the meta-frontier. Equivalently, the SOCB and FJVB bank groups are better able to achieve the industry level of efficiency.

O'Donnell *et al*. (2008) attribute the technology gaps of different groups in general (classified by characteristics of the physical, social and economic environment) to the specific policies and programs adopted to improve efficiency. From the perspective of the Vietnamese banking sector, different policies have been applied to different bank groups in the post-WTO era that would likely result in different potential outcomes. For instance, business groups are allowed to take part in private banks. Accordingly, credit was channelled to projects that were relevant to the interests of these business groups rather than the best projects available, resulting in higher NPLs. A weak supervisory

[71] The aggregate MTRs are calculated as the ratio of the aggregate technical efficiency scores of groups estimated by group frontiers over those estimated by the meta-frontier. For details on calculating aggregate technical efficiency, see Subsection 4.3.2.

and regulatory framework has exacerbated this situation. No law on cross-ownership has been implemented and defaults relating to insider trading have not been detected in time. These issues are barriers that prevent JSBs from achieving the meta-frontier and serve to widen the technology gap between their frontier and the meta-frontier. Meanwhile, SOCBs, under the privatisation process, have conducted a number of measures aimed at improving their performance, such as equitising and selling shares to private sector, calling for foreign strategic investors and upgrading their standards of corporate governance and risk management.

Using mean MTRs, conflicting results were obtained when comparing the technology gaps of the SOCB group frontier and the FJVB group frontier to the meta-frontier. If the operating approach is utilised the gap in the SOCB group is bigger than that of the FJVB group (0.9556 versus 0.9602 using basic DEA estimates or 0.9476 versus 0.9585 using bias-corrected estimates). This difference can be explained by the fact that foreign and joint venture banks are better in terms of cost and risk management (Havrylchyk, 2006; Lensink*et al*., 2008). Nevertheless, this result is in contrast to the case of applying the intermediation approach to calculate group MTRs. Under this approach, the MTR of the SOCB group is 0.9539, which is larger than that of the FJVB group (0.9400) using the basic DEA method. The result is similar when the bias-corrected estimates are considered.

The aggregate MTRs obtained by basic and bootstrap DEA methods give inconsistent results when comparing the ratios of the SOCB versus FJVB groups. For example, under the operating approach, the aggregate MTR of SOCBs is larger than that of FJVBs (0.9920 versus 0.9652) employing basic DEA. However, the result is reversed when looking at the bootstrap DEA results (0.9515 versus 0.9675). The same

circumstance can be observed under the intermediation approach. The aforementioned inconsistency can be explained by the fact that aggregate technical efficiency takes into account the relative importance of each bank (as measured by bank output shares, see Subsection 4.3.2) when calculating the aggregate MTRs of groups while mean MTRs consider all banks equally.

Table 6.1: MTRs of Vietnamese bank groups for the period 2005–2012

	Operating approach				Intermediation approach			
	Mean MTRs		Aggregate MTRs		Mean MTRs		Aggregate MTRs	
	DEA	DEA*	DEA	DEA*	DEA	DEA*	DEA	DEA*
JSB	0.9056	0.9000	0.9066	0.8984	0.8993	0.8842	0.8767	0.8652
SOCB	0.9556	0.9476	0.9920	0.9515	0.9539	0.9468	0.9927	0.9708
FJVB	0.9602	0.9585	0.9652	0.9675	0.9400	0.9202	0.9336	0.9830

Notes: DEA and DEA* columns present MTRs estimated by basic and double-bootstrap two-stage DEA methods respectively. MTR is the meta-technology ratio. JSB is the joint stock bank group; SOCB is the state-owned bank group and FJVB is the foreign and joint venture bank group.

6.3 Analysis of the impact of environmental variables on bank efficiency

In this section bank efficiency scores are regressed against a set of variables including those proxied for bank characteristics, policy changes and the time trend. Four regression models are used including the meta model based on the meta-frontier and three group models based on the group frontier. The metamodel includes all the variables mentioned in Table 5.5. The JSB model excludes P (privatisation dummy) as privatisation only impacts the SOCB group. The SOCB model excludes BG (equity participation by business groups dummy) and RU (rural-urban transformed JSB dummy) because equity participation by business groups and rural-urban transformation only apply to JSB group members. Privatisation and selling equity to foreign strategic

investors as a component of the privatising process happened at the same time so it is impossible to distinguish between the P and FSI (domestic banks with foreign strategic investors) dummies in the SOCB model. Thus, the FSI dummy is excluded. All four reform measures (BG, P, FSI and RU) only occurred for domestic banks, resulting in their exclusion from the FJVB model. Table 6.2 below presents the empirical results for the impact of the explanatory variables on bank efficiency for both the operating and intermediation approaches.

Table 6.2: Regressing environmental variables on bank technical efficiency scores estimated by meta- and different group-frontiers using double-bootstrap two-stage DEA.[72]

	Operating approach				Intermediation approach			
	Meta model	JSB model	SOCB model	FJVB model	Meta model	JSB model	SOCB model	FJVB model
Intercept	1.2575***	1.1258***	1.3069***	2.4120***	2.3684***	2.9128***	2.0761***	1.2274***
BG	0.0907*	0.1034***			0.0023	0.0632		
P	-0.7375***		-0.1482**		-1.0477***		0.7439***	
FSI	-0.0670	-0.0909**			-0.0204	-0.0902		
RU	0.1280**	0.1025***			0.2603***	0.2465**		
LA	0.4851***	0.5146***	-0.3998***	-0.8174**	-1.7541***	-2.8191***	-1.0977***	-0.4798
EA	1.5087***	0.8785***	4.6005***	0.9872**	-0.0939	0.7490	8.8515**	-1.8494**
ROA	-10.1884***	-8.5261***	-16.4308***	-34.3488***	-2.5402	-10.4705**	-76.5449***	10.4718*
T	-0.0512***	-0.0391***	-0.0095	-0.0418	-0.0258*	-0.0949***	-0.1411***	0.0635

Notes: BG - JSBs with equity participation from business groups, P - SOCBs after privatisation of SOCBs, FSI - domestic banks with foreign strategic investors, RU - rural-urban transformed JSBs, LA - loan to asset ratio, EA - equity to asset ratio, ROA - return on assets ratio, T - time trend variable. The coefficients with *, ** or *** are significant at 10, 5 or 1% respectively.

[72] For more detail on the confidence intervals of these coefficients, see Table B1 to Table B4 in Appendix B.

6.3.1 Impact of reform measures conducted in the post–WTO period on bank efficiency

Participation in the banking sector of state-owned and private business groups (BG)

One of the reform measures in the post-WTO period is that the SBV required commercial banks to intensively increase their capital. To catch up with the new capital requirement, numerous JSBs called for equity contributions from business groups. Subsequently, cross-ownership between banks and these industrial groups was established.[73]

Under the operating approach the BG coefficient, representing the impact of this relationship, is positively significant in the case of the metamodel at the 10% level and is significant at the 1% level in the JSB model. Joint stock banks with equity participation from industrial groups are less efficient than other banks not only in the same group but also in the other groups. In the intermediation approach case the result is similar but insignificant. The deterioration of JSB efficiency due to cross-ownership can be explained by two points. First, cross-ownership can reduce competition by facilitating collusion among firms that can be implemented by exchanges of practical information and establishing collusive strategies (see Trivieri, 2007). This obstacle to competitiveness can lead to an inefficient allocation of a firm's resources. The second point is that under a weak supervisory and regulatory framework, such as Vietnam has, cross-ownership can result in poor governance and connected lending. This is explained by the agency problem where companies playing a role as major bank shareholders pursue different incentives that result in a misallocation of loans to projects they favour rather than monitoring these banks efficiently and appropriately (Laeven, 1999;

[73] For a detailed discussion of cross-ownership, see Chapter 2.

Williams and Nguyen, 2005). Other empirical studies also highlight the abovementioned points. For example, Laeven (1999) shows that company-owned and family-owned banks in East Asian countries (Thailand, The Philippines, Malaysia and Korea) are the most risky and were subject to restructuring plans in the post-EAFC period.

Privatisation of SOCBs (P)

The coefficient for variable P (indicating privatisation of SOCBs) is revealed to be negative (-0.7375) at the 1% level of significance for the metamodel under the operating approach. This result demonstrates that privatised SOCBs are more efficient in terms of profit maximisation than other banks regardless of their ownership. However, it is important to know whether SOCBs, after being privatised, perform better than non-privatised SOCBs. Using the SOCB model the value of the P coefficient is negative (-0.1482) and significant at 5%.Accordingly one can conclude that equitised SOCBs achieved higher efficiency than non-equitised SOCBs. It can be expected that privatisation in general, and the participation of foreign investors in particular, have improved the performance of SOCBs as the operations of these banks are based on commercial incentives.

Under the intermediation approach and the meta model, the coefficient of P is negative (-1.0477) and significant at the 1% level indicating that privatised banks perform better than other banks belonging to different ownership types. However, the result is reversed in the SOCB model with a positive coefficient (0.7439). This implies that the privatised banks are less efficient than other SOCBs in terms of providing lending services. Some may argue that after being privatised the equitised banks become more cautious in their

operations under the supervision of domestic and foreign shareholders and, hence, they take less risks in their lending decisions. While intervention from central or local government on the operations of these banks is abandoned, this is not the case for the other non-equitised SOCBs which are still totally owned by the State. These purely state-owned banks find it easier to lend with support from the State and, therefore, they make loans under the direction of the government. This explains why they are more efficient when providing intermediation services but less efficient in terms of profit maximisation in comparison with privatised banks.

Bonin *et al*. (2005b) show that partial privatisation of SOCBs, in the cases of Vietnam and China where the State retains a controlling interest, cannot generate a performance improvement since, as the dominant shareholder, the State is continuously in a strong position to run the banks and subsequently there is no change in corporate governance. Furthermore, Kraft *et al*. (2006) found that comprehensive privatisation of public banks but incorporating no management modifications can result in a poorer performance in comparison with other bank ownership types. This study and that conducted by Berger *et al*. (2009) for the case of China under the impact of WTO entry, contradict Bonin *et al*. and suggest a positive influence of partial privatisation on SOCB performance. In the case of a less transparent environment, like that of Vietnam and China, SOCBs have to increase the quality of their management when being privatised to satisfy the standards of joint stock companies and as privatisation is in parallel with IPOs, they must upgrade accountability by publishing and announcing financial reports. These requirements push the SOCBs to improve their efficiency and competitiveness.

Foreign strategic investors (FSI)

In the case of the JSB model, under the operating approach, the nexus between bank efficiency and FSI is a negative result, significant at 5%. A similar result, but not significant, is found in the meta model. Under the intermediation approach the relationship is also negative but insignificant in both the meta and JSB models. It seems that the participation of foreign investors helps private banks improve their efficiency. This finding is in line with Berger *et al.* (2009) where they found a positive relationship between minority foreign ownership and bank performance in the Chinese banking sector. Berger *et al*. investigated mechanisms that transfer the positive impacts of minor foreign ownership onto domestic bank efficiency. One mechanism is that minority foreign shareholders can attain positions on the boards of directors of banks and use these positions to improve the quality of corporate governance and risk management. The other mechanism is that, through overseas strategic investors, domestic banks are encouraged and more confident to go public and list equity products on the stock exchange.

Transforming rural JSBs to urban JSBs (RU)

Transformed JSBs perform more inefficiently than not only other JSBs but also than banks belonging to any other ownership form. The evidence for this is that estimates of the RU parameters are positive at 0.1280 (5% significance level) and 0.1025 (1% significance level) under the meta and JSB models respectively when the operating approach is applied. In the case of the intermediation approach, these estimates are also positive at 0.2603 (1% significance level) when estimated by the meta model and 0.2465 (5% significance level) when estimated by the JSB model. There are two possible reasons for this. First, governance capability is inadequate. Transformed banks have to cover a significantly larger range of operations than they had done before. To

become urban banks their customer base and assets had to increase many times over in only two or three years and many branches were opened nationwide. The second is that insufficiently selective decisions by the SBV on awarding licences to rural banks resulted in a rapid growth of credit by inexperienced bankers which leading to risk taking and failure to adequately diversify their assets. In reality, many of the small transformed JSBs used the bulk of their credit to purchase property and stocks.

6.3.2 Specific bank characteristics (control variables)

Loan to asset ratio (LA)

Hasan and Marton (2003) see the LA variable as a proxy that captures variations in traditional banking services. Under the intermediation approach a positive association (negative result) between the loan to asset ratio and bank efficiency across the meta and three group models is found. This outcome is in line with the research conducted by Chortareas *et al*. (2013) supporting the argument that banks engaging more in traditional activities are more efficient. This can be explained by an expansionary monetary policy that was implemented to stimulate economic growth during the pre- and post-WTO periods and the fact that loans represent the bulk of bank assets. Domestic banks were in a race to expand branches nationwide and attract deposits from households and corporations. Under constraints relating to human and physical resources, banks maximised their capabilities of providing intermediation services and expected that the loans would bring back high profitability. This expectation can be examined by using the profit criteria of efficiency.

Under the operating approach the regression results demonstrate a diversity of bank group responses to the LA variable. In the JSB model the estimate of the LA parameter

is 0.5146 at the 1% significance level, indicating a negative relationship. By contrast a positive association is obtained with an estimated parameter value of -0.3998 at the same 1% level in the case of SOCBs and -0.8174 at the 5% level in the case of the FJVB model. The different responses to LA can be clarified based on the characteristic of liquidity. The liquidity of private banks is in serious trouble[74] which is not the case for the two other groups. In the illiquid condition, Altunbas *et al.* (2000) consider the loan to asset ratio as a proxy for liquidity risk that raises the cost of attracting deposits and borrowing. Thus, the negative relationship could indicate that the less efficient banks are more illiquid as recorded in the JSB model. However, the view of Altunbas*et al.* (2000) cannot be applied in the SOCB and FJVB models due to the more liquid condition of these two groups. Instead, the author follows the view of Hasan and Marton (2003) on the transaction cost of shifting into non-traditional assets[75]. Banks, when decreasing traditional assets (loans and advances) and increasing non-traditional assets (investments and securities), incurred higher costs; hence, a lower LA ratio can result in lower profitability.

Equity to asset ratio (EA)

The equity to asset ratio is a criterion to identify the financial soundness of a bank and a banking system. A bank with a higher EA ratio is safer in terms of capital and is in a stronger position to defend risks relating to equity losses. In the literature, the positive link between capital strength and efficiency is theoretically explained. According to Jeitschko and Jeung (2005), the managers of banks with less capital have more

[74] During the credit boom period (2005−2010) in Vietnam, the interest rate on the interbank market reached a record high of 30%/year caused by a high demand for cash from illiquid JSBs (Pincus, 2009; NAEC, 2012).

[75] The 2005−2012 period witnessed a significant change in banks' asset structure. On average, the portion of traditional assets decreased from 61% in 2005 to 51% in 2012.

incentives to engage in moral hazards because they face less shareholder scrutiny than banks with higher capital ratios. Berger and De Young (1997) point out that banks with higher risk levels in the medium-term have to employ more inputs to administer these higher risks which results in a decline of efficiency. Regulators can also force banks to increase capital and adequately account for risk-related costs commensurate with the degree of risk taken (Gropp and Heider, 2010). The mainstream empirical studies support a positive association between capital and efficiency (e.g, Fries and Taci, 2005; Fiordelisi *et al*., 2011).

However, in a shallow and weak regulatory/supervisory framework like Vietnam's, these relationships may be reversed. Risk-related costs and equity can be inadequately accounted for; thus, figures on bank profitability are not commensurate with the level of risk (Laeven, 1999). Moreover, outdated Vietnamese accounting standards have not caught up with risks occurring within banks (IMF, 2012). These factors implicitly stimulate banks to provide more intermediate services (especially loans) and obtain a higher rate of return. This cycle is repeated many times and creates a negative relationship between capital and efficiency. Banks that have lower equity to asset ratio, will provide more intermediate services to customers and achieve a higher level of profitability. Under the operating approach, all four models give similar and significant results, showing a negative association (positive result) between the EA ratio and bank efficiency.[76]

It is worth noting that domestic banks react differently to the EA variable when compared with their foreign rivals under the intermediation approach. A negative

[76] Rossi *et al.* (2009) also found a negative relationship between capital and efficiency using the Granger-causality methodology to investigate the impact of diversification of bank size/industry on cost/profit efficiency, capital and risk in Austria from 1997−2003.

association between the EA and bank efficiency in domestic banks (significant in the case of the SOCB model but insignificant in the JSB model) was obtained. This can be explained by the expansionary monetary policy implemented in the pre- and post-WTO era. Domestic banks were encouraged to lend to the economy in order to stimulate economic growth. However, this result is reversed in the FJVB model due to the limitations on attracting deposits and lending in Vietnamese dong imposed on foreign and joint venture banks.

Return on assets (ROA)

ROA is the ratio of before-tax profit to total assets and is used to measure bank profitability. The meta model and the other three group models come to a consensus with a positive relationship between ROA and bank efficiency under the operating approach, employing interest and non-interest revenues as outputs and interest and non-interest costs as inputs. This result is also consistent with that obtained by Das and Ghosh (2006) and Fang *et al*. (2011).

Nevertheless, these results are reversed if the banks' capability to provide intermediation services is used as the criterion. ROA is positively related to bank efficiency in the JSB and SOCB models with the relevant coefficients of -10.4705 (5% significance level) and -76.5449 (1% significance level) respectively. This result shows that the bulk of domestic banks' revenues are created from lending activities. Meanwhile, the profitability of foreign rivals reacts negatively to bank efficiency. The proof is that the relevant coefficient in the FJVB model is 10.4718 which is significant at the 10% level. This is because interest revenue is not a major item and, due to the

diversification of banking services, the profit of foreign and joint venture banks is less dependent on lending services than the domestic banks.

Time trend (T)

The private banks' efficiency increased during the period 2005–2012. The evidence for this is that the coefficients of the time trend variable are -0.0391 (1% significance) and -0.0949 (1% significance) under both the operating and intermediation approaches respectively. Only when using the intermediation approach in the SOCB model can an increasing trend of bank efficiency be observed. By contrast, changes of bank efficiency in the FJVB model under both approaches are not revealed. The time trend under meta-models is not obvious (increasing or decreasing), and this result is in line those in section 5.3 that there is no significant change in terms of efficiency between the pre- and post-WTO periods.

6.4 Productivity analysis using the aggregate Malmquist total factor productivity index

Due to the fact that the data sample is unbalanced and balanced data is necessary to capture productivity over time, a number of banks with the necessary data covering the years 2007–2012 are chosen. Foreign banks which only started operating in Vietnam from 2009 were omitted due to their short time period in the market. This leaves 24 banks, consisting of five SOCBs and 19 JSBs, in the sample which can be used for productivity analysis. Using both the intermediation and operating approaches, productivity changes and its component changes for each group as well as the whole banking sector is now measured and compared.

6.4.1 Intermediation approach

In general, when viewed under the intermediation approach, banking sector productivity has slightly regressed (see Table 6.3). This is because the AMPI is 0.9770 indicating that productivity decreased 2.3% per year during the period from 2007–2012. The reason for this trend can be found by analysing changes in the productivity components. The index of aggregate efficiency change is 1.0049 and this is very close to unity suggesting that the efficiency of the banking sector has remained constant. Thus, the change of productivity is mostly explained by the other component, technology, with the technical change index being 0.9722 implying a 2.88% decrease per year. The negative technology change effect is more serious for JSBs than for SOCBs. Technical change[77] declined at an annual rate of 4.37% in the case of JSBs which is much greater than the 1.31% decline in the case of SOCBs.

The technology regression can be explained in two ways. First, although the period 2000–2005 witnessed a booming growth of Automatic Teller Machines (ATMs) and all banks applied core banking software to manage their banking operations, electronic transactions over the Internet, up to now, have been very limited due to a lack of regulation and legalisation. Second, the quality of bank governance has not improved over the period. Due to cross-ownership between business groups and JSBs a number of senior positions in these banks are held by representatives coming from industry who are less experienced in the financial sector. Foreign investors are allowed to join the

[77] Oh and Lee (2010) apply the meta-frontier approach in the context of Malmquist index. And they use BPC (best practice change) index to measure the technology change within a group. Furthermore, to examine which groups leading the growth in the industry, Oh and Lee (2010) use the TGR (technology gap ratio) and TGC (technology gap change). Although their method has advantages when investigating the technology changes in groups but it cannot be applied in my thesis. This is because the number of banks in the SOCB group is too small, five banks; hence, if estimating the SOCB group frontier, it would lead to unreliable results.

banking sector, but only as minority shareholders. Under the regulations set by the government the maximum equity that can be bought by foreigners is 30%. This restriction has inhibited long term involvement by foreign investors in the development of the banking sector and in terms of technology transfer.

The finding of technical regression is in line with the study of Nguyen and Simioni (2015) when they used the Färe-Primont index to measure Vietnamese banking productivity during the 2008−2012 period. They attribute the technical regression to changes occurring in the business environment of banks with two particular major challenges. First, Vietnam has faced macroeconomic instability since 2007 with a double-digit inflation rate, large trade and fiscal deficits and substantial volatility in exchange and interest rates (WB, 2012).[78] These uncertainties increase market-risk relevant costs which cannot be avoided and all banks, including the best practice ones, suffer. Second, a high level of non-performing loans has deteriorated banks' capacity to provide intermediation services. Increasing the proportion of bad debts in total bank assets leads to a decline of credit that could otherwise be utilised for new projects.[79]

In particular, the trend of productivity of the private and public banks is decreasing at 2.25% and 1.35% respectively. These decreases are mainly explained by technical regression at the rates of 4.37% for JSBs and 1.31% for SOCBs. While there was seemingly no improvement in efficiency of public banks (with a 0.9996 efficiency index), the level of efficiency has increased at an annual rate of 2.21% in their private rivals.

[78] The negative real interest rate due to high inflation discouraged depositors from keeping their money in banks. Instead, they withdrew their deposits and invested in more profitable assets such as property or gold (NAEC, 2012).

[79] For details on bad loans, credit growth and a review of the Vietnamese banking sector during the 2007−2012 period, see Chapter 2.

One may argue that even though private banks have witnessed a large declining trend in productivity and technical regression, the JSBs, on average, have experienced an increase in technical efficiency. These seemingly conflicting issues can be reconciled by the fact that JSBs have benefited from the expansionary monetary policy conducted from 2007−2011. The private banks broadened their geographical scope, built more offices and recruited more staff. More deposits were attracted and more loans were provided. Accordingly, efficiency increased continuously till 2011 (see Table 6.3). In 2011, the government changed monetary policy from being expansionary to being contractionary and, as a result, efficiency in the 2012/2011 period decreased. During the expansionary period (2007−2011) which was characterised by macroeconomic turmoil[80], there was no significant or positive change of technology, quality of governance or risk management; therefore, the period observed a regression of technical factors in the JSB group (NAEC, 2012). The increasing efficiency factor (2.21%/year) is smaller than the rate of technical regression (4.37%/year); hence, overall, the productivity of the JSBs declined.

Table 6.3: Productivity of the Vietnamese banking sector over the years 2007–2012 under the intermediation approach

	08//07	09//08	10//09	11//10	12//11	07—12
AMPI(JSBs)	0.8996	1.0153	1.1499	0.8870	0.9579	0.9775
AEFCH(JSBs)	*1.0475*	*1.0222*	*1.0375*	*1.0351*	*0.9700*	*1.0221*
ATECH(JSBs)	*0.8588*	*0.9932*	*1.1084*	*0.8569*	*0.9875*	*0.9563*
AMPI(SOCBs)	0.9202	0.9653	1.0344	0.9493	1.0711	0.9865
AEFCH(SOCBs)	*1.0000*	*1.0000*	*0.9942*	*0.9991*	*1.0047*	*0.9996*
ATECH(SOCBs)	*0.9202*	*0.9653*	*1.0404*	*0.9502*	*1.0660*	*0.9869*
AMPI(All)	0.9108	0.9716	1.0774	0.9178	1.0170	0.9770
AEFCH(All)	*1.0132*	*0.9991*	*1.0065*	*1.0164*	*0.9894*	*1.0049*
ATECH(All)	*0.8990*	*0.9725*	*1.0704*	*0.9030*	*1.0278*	*0.9722*

Notes: AMPI: Aggregate Malmquist Productivity Index; AEFCH: aggregate efficiency change; ATECH: aggregate technical change; JSBs: joint stock banks; SOCBs: state-owned commercial banks.

[80] During the period 2007−2011,the inflation rate was a two-digit number. In 2008, this rate is quite high at 23%.

6.4.2 Operating approach

Productivity of the banking sector under the operating approach has changed between private and state-owned banks. On average, SOCBs have improved their performance at a rate of 1.43% annually (see Table 6.4) over the period 2007–2012. This productivity increase is explained primarily by changes in technology, which grew at 1.49% per year. Meanwhile, the efficiency factor changed only slightly during the same period (the efficiency component index is 0.9994, equivalent to a 0.06% decrease). This technical progress can be explained by the fact that four of the five SOCBs were equitised and their equity was listed in the stock exchange during the period 2005–2008. When they went public, their operations had to be properly restructured to comply with the strict regulations of the Vietnam Security Commission on accounting standards and financial and operating reports. The participation of domestic and foreign investors also pushed the SOCBs to improve their productivity as they expected to receive a higher rate of return on their investments. However, there is a question on the conflicting performance of SOCBs under the two input/output approaches as it was found to decline under the intermediation approach. During the equitisation process the SOCBs were forced to turn from policy-based to commercial-based banking activity, and their priority became profit, not how best to provide loans for economic growth. Bad loans were resolved when policy lending was transferred to two specific banks - the Vietnam Development Bank and the Vietnam Bank for Social Policies. Moreover, foreign strategic investors play a substantive role in applying advanced technology, risk management and bank governance when their representatives hold high-ranking positions in SOCBs. These positive changes explain why the rate of NPLs significantly decreased and resulted in

lower costs for loan-loss provisioning in particular and a decrease of total operating costs in general.

In contrast, the JSBs regressed at a faster rate, 4.67% each year, due to decreases of both efficiency (-1.63%) and technical change (-3.09%). There are three main reasons that led to this performance regression in the private banks. First, the SBV substantially loosened its regulations when permitting 13 rural banks to transform into urban banks in 2006–2007 (NAEC, 2012). The quality of management in these banks was problematic and could not keep up with their substantially larger scope of operations. Before being transformed, they had focused on rural areas and most of their loans were allocated to agricultural activities. On becoming urban banks, they provided services nationwide to any economic field including commerce and industry. Operating on a larger scope but with an unchanged quality of management explains the low efficiency of these transformed banks. Second, cross-ownership between banks and industrial groups deteriorated bank performance. Under pressure from the SBV to recapitalise, small JSBs had to increase their capital levels by up to 10 times in a five-year period (NAEC, 2012). Calling for equity participation from large banks, private business groups and SOEs became a popular option which, in return, resulted in complicated cross-ownerships with JSBs (NAEC, 2012; IMF, 2012). Most loans were allocated to related parties rather than to the most profitable projects, resulting in a higher non-performing loan rates for JSBs[81]. In a general sense, this poor allocation of financial resources led to an inevitable loss of GDP growth. A lack of regulation on cross-ownership and the weak capability of supervisory departments worsened this situation. Third, a collapse of

[81] For example, 80% of total loans of the First bank , a JSB, was lent to its holding company and 40% of the total loan is non-performing and this data was recorded at the end of 2010 (NAEC, 2012).

speculative markets, such as real estate or stock, subsequently created mounting bad loans and worsened the profitability of JSBs.[82]

Under the operating approach to data, the Vietnamese banking sector witnessed regression over the years 2007–2012. Specifically, the sector's productivity decreased 1.19% and this can be decomposed into an efficiency change of -0.91% and technical change of -0.28%. Although public banks experienced progress, it was not enough to offset the decline in productivity of the JSBs.

Table 6.4: Productivity of the Vietnamese banking sector over the years 2007–2012 under the operating approach

	08//07	09//08	10//09	11//10	12//11	07—12
AMPI(JSBs)	0.7673	1.0972	1.0082	0.9320	0.9953	0.9533
AEFCH(JSBs)	*0.8892*	*1.1003*	*0.9961*	*1.0019*	*0.9435*	*0.9837*
ATECH(JSBs)	*0.8630*	*0.9972*	*1.0122*	*0.9302*	*1.0549*	*0.9691*
AMPI(SOCBs)	1.0845	1.0174	0.9712	1.0111	0.9910	1.0143
AEFCH(SOCBs)	*0.9755*	*1.0223*	*1.0004*	*1.0003*	*0.9992*	*0.9994*
ATECH(SOCBs)	*1.1117*	*0.9953*	*0.9708*	*1.0109*	*0.9918*	*1.0149*
AMPI(All)	0.9513	1.0460	0.9850	0.9765	0.9842	0.9881
AEFCH(All)	*0.9416*	*1.0496*	*0.9965*	*1.0024*	*0.9677*	*0.9909*
ATECH(All)	*1.0103*	*0.9966*	*0.9884*	*0.9742*	*1.0170*	*0.9972*

Notes: AMPI: Aggregate Malmquist Productivity Index; AEFCH: aggregate efficiency change; ATECH: aggregate technical change; JSBs: joint stock banks; SOCBs: state-owned commercial banks.

6.5 Productivity analysis using the Hicks−Moorsteen total factor productivity index

6.5.1 Intermediation approach

Table 6.5 lists the geometric average values of different measures of the banks' TFP changes and its components under the intermediation approach to input/output data. An average value of the Hicks−Moorsteen index greater than unity indicates an

[82] The Vietnam stock market index (VNI) plummeted from a peak of 1197 points in November 2007 to bottom out at 235.50 points (equal to approximately one fifth of the peak) in February 2009 (NAEC, 2012)..

improvement and less than unity implies a regress of the measure. The average value of the TFP index over the years 2007−2012 is 0.9609, indicating a decrease of the banking sector's productivity by 3.91%. This decrease is due to a large technical regress of this industry with the component index at 0.8537, indicating a decreasing rate of 14.63%. This decrease is only partially offset by an increase of overall productive efficiency (TFPE) by 12.55%.

Both bank groups experienced a decrease of productivity. Private banks experienced a productivity decline of 2.19% while their public counterparts witnessed a productivity deterioration of 5.6%. Both groups experienced technical regress and an overall efficiency improvement. The two components of TFP efficiency including output-oriented technical efficiency (*OTE*) and output-oriented scale-mix efficiency (OSME) improved. In detail the values of *dOTE* and *dOSME* are 1.0103 and 1.1140, and both values are greater than unity. This result shows that the Vietnamese banking sector improved its management and positively changed the structure and scale of services provided to their customers in the aftermath of WTO entry. However, the observed changes in overall productive efficiency originated mainly from scale and mix efficiency in comparison to technical efficiency (11.40% versus 1.03%).

Table 6.6 shows the development of output-oriented scale and mix efficiency and its components following the decomposition as mentioned in equations (4.53) and (4.54). *OSME* of the whole banking system, on average, increased by 11.4% annually over the period 2007−2012. Moreover, the results also recorded a higher *OSME* rate for the JSBs group at 12.97% while it is 9.86% for the case of SOCBs. This increase in scale and mix efficiency can be mainly explained by an equal increase in scale efficiency, whether measured directly by *OSE* (11.49%) or residually by *ROSE* (10.83%). In fact, mix

efficiency seems to be unchanged over the period as *dOME* (1.0054) and *dRME*(0.9993) are very close to unity.

Table 6.5: Changes in total factor productivity and its components using the Hicks−Moorsteen Index under the intermediation approach

	08//07	09//08	10//09	11//10	12//11	07—12
dHMI (JSBs)	0.8229	1.0518	1.1957	0.8640	1.0014	0.9781
dTech(JSBs)	*0.4965*	*1.0307*	*1.1420*	*0.8404*	*0.8941*	*0.8482*
dTFPE(JSBs)	*1.6575*	*1.0206*	*1.0470*	*1.0281*	*1.1199*	*1.1532*
dOTE(JSBs)	*1.0550*	*1.0149*	*1.0414*	*1.0116*	*0.9826*	*1.0208*
dOSME(JSBs)	*1.5711*	*1.0055*	*1.0055*	*1.0163*	*1.1397*	*1.1297*
dHMI (SOCBs)	0.9095	0.8428	1.0210	0.9294	1.0308	0.9440
dTech(SOCBs)	*0.4898*	*1.0170*	*1.3866*	*0.8368*	*0.8106*	*0.8593*
dTFPE(SOCBs)	*1.8570*	*0.8287*	*0.7363*	*1.1106*	*1.2716*	*1.0986*
dOTE(SOCBs)	*1.0000*	*1.0000*	*1.0000*	*1.0000*	*1.0000*	*1.0000*
dOSME(SOCBs)	*1.8570*	*0.8287*	*0.7363*	*1.1106*	*1.2716*	*1.0986*
dHMI (All)	0.8651	0.9415	1.1049	0.8961	1.0160	0.9609
dTech(All)	*0.4931*	*1.0238*	*1.2583*	*0.8386*	*0.8514*	*0.8537*
dTFPE(All)	*1.7544*	*0.9196*	*0.8780*	*1.0685*	*1.1934*	*1.1255*
dOTE(All)	*1.0271*	*1.0074*	*1.0205*	*1.0058*	*0.9913*	*1.0103*
dOSME(All)	*1.7081*	*0.9128*	*0.8604*	*1.0624*	*1.2039*	*1.1140*

Notes: dHMI: Hicks−Moorsteen index change; *dTech*: technical change; *dTFPE*: TFP efficiency change; *dOTE*: output-oriented technical efficiency change; *dOSME*: output-oriented scale-mix efficiency change; JSBs: joint stock banks; SOCBs: state-owned commercial banks.

Table 6.6: Changes in output-oriented scale-mix efficiency under the intermediation approach

	08//07	09//08	10//09	11//10	12//11	07—12
dOSME(JSBs)	1.5711	1.0055	1.0055	1.0163	1.1397	1.1297
dOME(JSBs)	*1.0299*	*1.0035*	*1.0203*	*1.0026*	*0.9865*	*1.0084*
dROSE(JSBs)	*1.5255*	*1.0020*	*0.9854*	*1.0136*	*1.1553*	*1.1202*
dOSE(JSBs)	*1.5950*	*1.0142*	*0.9841*	*1.0541*	*1.0959*	*1.1296*
dRME(JSBs)	*0.9850*	*0.9915*	*1.0217*	*0.9641*	*1.0400*	*1.0001*
dOSME(SOCBs)	1.8570	0.8287	0.7363	1.1106	1.2716	1.0986
dOME(SOCBs)	*1.0038*	*0.9966*	*1.0304*	*0.9954*	*0.9845*	*1.0020*
dROSE(SOCBs)	*1.8500*	*0.8315*	*0.7146*	*1.1158*	*1.2916*	*1.0964*
dOSE(SOCBs)	*1.9176*	*0.8400*	*0.7035*	*1.1106*	*1.2815*	*1.1003*
dRME(SOCBs)	*0.9684*	*0.9866*	*1.0467*	*1.0000*	*0.9923*	*0.9985*
dOSME(All)	1.7081	0.9128	0.8604	1.0624	1.2039	1.1140
dOME(All)	*1.0167*	*1.0010*	*1.0254*	*0.9990*	*0.9855*	*1.0054*
dROSE(All)	*1.6800*	*0.9128*	*0.8392*	*1.0635*	*1.2216*	*1.1083*
dOSE(All)	*1.7489*	*0.9230*	*0.8321*	*1.0820*	*1.1851*	*1.1149*
dRME(All)	*0.9767*	*0.9890*	*1.0341*	*0.9819*	*1.0159*	*0.9993*

Notes: dOSME: output-oriented scale-mix efficiency change; *dOME*: output-oriented mix efficiency change; *dROSE*: residual output-oriented scale efficiency change; *dOSE*: output-oriented scale efficiency change; *dRME*: residual mix efficiency change; JSBs: joint stock banks; SOCBs: state-owned commercial banks.

6.5.2 Operating approach

Table 6.7 presents changes in TFP and its components under the operating approach. The productivity of Vietnamese banks as measured by the Hicks−Moorsteen index experienced a decline by 2.49%/year during the years after WTO entry. This decline is mostly explained by technical regress at a decreasing rate of 13.18%. Even though the period witnessed an improvement of overall efficiency, increasing at a rate of 12.3%, this was inadequate to offset technical regress. Components of efficiency experienced different changes. While technical efficiency of the banking sector suffered a slight deterioration (*dOTE*=0.9941) the two other efficiencies, including scale and mix efficiency, achieved progress (*dOSME*=1.1297).

Table 6.8 shows results on how the *OSME* can be decomposed into two relevant components. Similar to the results under the intermediation approach the change of *OSME* is mostly due to scale efficiency that is either measured directly by *dOSE* or residually by *dROSE*, the respective rates of increase are 11.82% and 11.36%. The impact of mix efficiency is insignificant using both the *OME* and *RME* criterions; accordingly, they contributed only 1.45% and 1.03% to *OSME* growth, respectively. It is worth noting that the change of OSME is quite different across JSBs and SOCBs. While the data recorded a substantial change of OSME in private banks (22.81%) this is trivial in the case of their public rivals (3.91%).

Table 6.7: Changes in total factor productivity and its components using the Hicks−Moorsteen Index under the operating approach

	08//07	09//08	10//09	11//10	12//11	07—12
dHMI (JSBs)	0.8063	1.0387	1.0627	0.8667	1.0621	0.9609
dTech(JSBs)	*0.6999*	*0.6721*	*1.1035*	*0.5270*	*1.1377*	*0.7918*
dTFPE(JSBs)	*1.1521*	*1.5456*	*0.9630*	*1.6447*	*0.9336*	*1.2136*
dOTE(JSBs)	*0.9126*	*1.0812*	*0.9888*	*1.0122*	*0.9544*	*0.9882*
dOSME(JSBs)	*1.2625*	*1.4295*	*0.9739*	*1.6248*	*0.9783*	*1.2281*
dHMI (SOCBs)	0.9167	1.0172	0.9320	0.9409	1.1595	0.9894
dTech(SOCBs)	*0.7015*	*0.7196*	*1.2641*	*0.5899*	*2.0785*	*0.9521*
dTFPE(SOCBs)	*1.3067*	*1.4134*	*0.7373*	*1.5951*	*0.5578*	*1.0391*
dOTE(SOCBs)	*0.9742*	*1.0264*	*1.0000*	*1.0000*	*1.0000*	*1.0000*
dOSME(SOCBs)	*1.3412*	*1.3770*	*0.7373*	*1.5951*	*0.5578*	*1.0391*
dHMI (All)	0.8598	1.0279	0.9952	0.9030	1.1098	0.9751
dTech(All)	*0.7007*	*0.6954*	*1.1811*	*0.5575*	*1.5378*	*0.8682*
dTFPE(All)	*1.2270*	*1.4780*	*0.8426*	*1.6197*	*0.7217*	*1.1230*
dOTE(All)	*0.9429*	*1.0534*	*0.9944*	*1.0061*	*0.9769*	*0.9941*
dOSME(All)	*1.3013*	*1.4030*	*0.8474*	*1.6099*	*0.7387*	*1.1297*

Notes: dHMI: Hicks−Moorsteen index change; *dTech*: technical change; *dTFPE*: TFP efficiency change; *dOTE*: output-oriented technical efficiency change; *dOSME*: output-oriented scale-mix efficiency change; JSBs: joint stock banks; SOCBs: state-owned commercial banks.

Table 6.8: Changes in output-oriented scale-mix efficiency under the operating approach

	08//07	09//08	10//09	11//10	12//11	07—12
dOSME(JSBs)	1.2625	1.4295	0.9739	1.6248	0.9783	1.2281
dOME(JSBs)	*0.9801*	*1.0071*	*1.0539*	*1.0165*	*1.0492*	*1.0210*
dROSE(JSBs)	*1.2882*	*1.4194*	*0.9241*	*1.5985*	*0.9324*	*1.2029*
dOSE(JSBs)	*1.2509*	*1.4029*	*0.9741*	*1.6111*	*0.9868*	*1.2214*
dRME(JSBs)	*1.0093*	*1.0190*	*0.9998*	*1.0085*	*0.9914*	*1.0056*
dOSME(SOCBs)	1.3412	1.3770	0.7373	1.5951	0.5578	1.0391
dOME(SOCBs)	*0.9743*	*0.9695*	*1.0017*	*1.0885*	*1.0103*	*1.0080*
dROSE(SOCBs)	*1.3767*	*1.4203*	*0.7360*	*1.4655*	*0.5521*	*1.0309*
dOSE(SOCBs)	*1.2555*	*1.4864*	*0.7014*	*1.5374*	*0.5589*	*1.0238*
dRME(SOCBs)	*1.0683*	*0.9264*	*1.0511*	*1.0376*	*0.9982*	*1.0150*
dOSME(All)	1.3013	1.4030	0.8474	1.6099	0.7387	1.1297
dOME(All)	*0.9772*	*0.9881*	*1.0275*	*1.0519*	*1.0295*	*1.0145*
dROSE(All)	*1.3317*	*1.4199*	*0.8247*	*1.5305*	*0.7175*	*1.1136*
dOSE(All)	*1.2532*	*1.4441*	*0.8266*	*1.5738*	*0.7426*	*1.1182*
dRME(All)	*1.0384*	*0.9716*	*1.0252*	*1.0229*	*0.9948*	*1.0103*

Notes: dOSME: output-oriented scale-mix efficiency change; *dOME*: output-oriented mix efficiency change; *dROSE*: residual output-oriented scale efficiency change; *dOSE*: output-oriented scale efficiency change; *dRME*: residual mix efficiency change; JSBs: joint stock banks; SOCBs: state-owned commercial banks.

In summary, there is a consensus under both approaches to input/output data on the change of productivity as measured by the Hicks−Moorsteen TFP index as well as the causes of this change in the Vietnamese banking sector over the period 2007−2012. There is evidence that the banking system experienced productivity deterioration mainly due to technical regress. Although an improvement of TFP efficiency is recorded it was inadequate to offset the technology factor. Amongst a variety of efficiency measures, scale efficiency appears to be the most significant component contributing to the growth of overall productive efficiency.

The results based on both the Malmquist and Hicks−Moorsteen TFP index reveal a similarity about developments in the productivity of Vietnamese banks during the 2007−2012 period, which declined and the main cause of which is technical regress according to both approaches. However, due to the fact that the Malmquist index is not multiplicatively complete, other measures of efficiency, including scale and mix efficiency, cannot be seen via this approach (O'Donnell, 2012a). Consequently, results for Vietnamese banking productivity, as measured by the Malmquist index, are biased and incomplete.

6.6 Summary

By combining a meta-frontier analysis and a double-bootstrap two-stage DEA method this study measured and analysed the technology gap to the meta-frontier of each bank group frontier. The results showed that JSBs have the greatest technology gap in comparison with their public and foreign counterparts under both input/output approaches. SOCBs find it easier to mimic the industry frontier under the intermediation approach compared with FJVBs; however, the result is reversed when applying the

operating approach. Based on the meta and group models the impact on bank efficiency of environmental variables was examined. Reform measures conducted in the post-WTO period have had both negative and positive impacts on bank performance. These measures included equitisation of public banks and allowing foreign investors to take part in the banking sector, all aimed at fostering efficiency. In contrast, measures such as cross-ownership and rural-urban transformation have deteriorated the efficiency performance of the banking sector. Bank-specific variables including the loan to asset ratio, equity to asset ratio and return on assets responded differently in the different group models.

The analysis of productivity showed that the banking system witnessed a decline during the period 2007–2012 under both the operating and intermediation approaches. This issue can be explained by regression of the technical component. While the efficiency component slightly increased under the intermediate approach, it decreased under the operating approach.

The next chapter presents a number of policy implications and recommendations to improve Vietnamese bank efficiency based on this chapter's empirical findings. It recommends policies geared towards establishing a competitive banking market, improving related institutions and consolidating the legal and regulatory framework.

Chapter 7: Policy implications and recommendations

7.1 Introduction

The technical efficiency and productivity of the Vietnamese banking sector was empirically analysed in the two previous chapters using different approaches to inputs/outputs for the period 2005−2012 which encompassed the pre- and post-WTO periods. The author has found that state-owned banks are the most efficient and have the smallest technology gap relative to the meta-frontier. In contrast to the mainstream view, joint stock banks are the least efficient group and have the biggest technology gap. The impact of reform measures such as transforming rural to urban banks and allowing business groups to become involved in the banking sector have contributed negatively to bank performance.

We find evidence that privatisation of the SOCBs can improve their capacity to earn profit but has reduced intermediation efficiency. The participation of foreign investors has improved the efficiency of joint stock banks. Regardless of ownership the results illustrate a negative relationship between bank capitalisation and performance under the operating approach. Foreign and joint venture banks are less dependent on lending activities and are more diversified in their operations than domestic banks. However, the responses of various bank groups to the same explanatory factors can be different. For example, the operating efficiency of state-owned banks is positively related to the loan to asset ratio while a negative relationship is recorded in the case of joint stock banks. The productivity of banks declined during the period studied, mainly due to technological regress. These findings provide an appropriate framework for relevant

authorities who are responsible for the initiation of innovative measures to improve the efficiency and productivity of the Vietnamese banking sector.

The perspective of economic integration will be a main driving force for the liberalisation and restructuring of the banking sector in the next decade (Leung, 2015; Thanh, 2015). The ASEAN Economic Community (AEC), of which Vietnam will be a member, will be created in December 2015. Restrictions on the banking sector are targeted to be substantially removed by 2020 for all AEC members. By 2015, among the sub-sector including Vietnam, Laos and Cambodia, banking services (acceptance of deposits and other repayable funds from the public, lending of all types, financial leasing, payment and money transmission, and guarantees) will be freely transacted across these countries.

The Trans Pacific Partnership (TPP), a regional regulatory and investment treaty led by the United States and including Vietnam, is expected to be established by 2020. The TPP covers important issues such as agriculture, intellectual property, services and investments. In the financial sector, including commercial banks, the TPP allows financial institutions in a member country to provide services to their clients in other countries without establishing overseas operations. A supplier of a TPP country may also provide any financial services in another TPP market if domestic companies in that market are allowed to do so (Summary of Trans-Pacific Partnership Agreement, Chapter 11: Financial Services).[83] The level of financial liberalisation embedded in the TPP is greater than that of any other free trade agreement to which Vietnam is a party (Thanh, 2015). The AEC and TPP require Vietnam to liberalise the banking market for foreign

[83]A summary of theTrans-Pacific Partnership Agreement can be downloaded from: *https://ustr.gov/about-us/policy-offices/press-office/press-releases/2015/october/summary-trans-pacific-partnership*

investors substantially[84] and this presents challenges for the SBV and the government to improve banking sector performance.[85]

Challenges exist not only from outside but also inside the banking system.

First, the issue of ownership includes public ownership and cross-ownership. Public-owned banks still dominate the banking system and remain under the control of the SBV and the government. Some argue that privatisation would drive them in a more commercially-based direction (Pincus, 2009; IMF, 2012); nonetheless, while three of the big four banks have been equitised, the bulk of their equity is still owned by the State, thereby ensuring their ongoing favour and substantial influence. Meanwhile, cross-ownership within private banks has been overwhelming and resulted in insider trading and misallocations of financial resources.

In the context of Vietnam's transition economy, the second internal challenge emanates from a business environment where banks/companies belonging to different types of ownership are not treated equally. Public banks are preferred and receive privileges from the State which is not the case for their private counterparts. Foreign banks face

[84] Vietnam has been a full member of the WTO since 2007. In the banking sector all commitments to the WTO have been implemented. As mentioned previously the impact of the WTO on Vietnam has been to open its banking market to foreign investors in terms of: buying equity in domestic state-owned and domestic private banks; opening of 100% foreign-owned banks in Vietnam (e.g, HSBC, Standard Chartered Bank); and foreign bank branches being allowed to receive deposits in Vietnamese dong. However, there are still limits imposed on foreign investors. Specifically, they cannot take over more than 30% of the total equity of a domestic bank and are not permitted to participate in mergers and acquisitions; furthermore, they bear further constraints in terms of geographical range and services provision. Hence, we can say that liberalisation of the banking sector in Vietnam is incomplete and quite different from that which occurred in the Eastern and Central European economies where all restrictions on foreign investors were removed and there was no discrimination between foreign and domestic investors. Consequently, there is room for Vietnam to continue liberalising its banking sector substantially and more comprehensively under the AEC and, especially, the TPP agreement. Further liberalising measures are mentioned in sections 7.2, 7.3 and 7.4.

[85] Thanh (2015) shows that overlapping forms of economic integration (WTO, AEC, TPP) can create a complex web of commitments and arrangements with huge distortions; however, all economies have to ensure maximal liberalisation under each scenario and access to benefits of related parties by domestic institutional and legal reforms accompanying the implementations of these trade agreements.

considerable restrictions on their operations in terms of attracting deposits and lending in Vietnamese dong, and this issue has prevented them from achieving a higher level of efficiency and approaching the industry production frontier (the meta-frontier discussed in Chapters 4, 5 and 6).

Third, it is widely accepted that the regulatory and supervisory framework plays a key role in establishing and maintaining a sound and sustainable financial system (Beck *et al.*, 2000; Barth *et al.*, 2004). Recent financial crises such as the EAFC and GFC have pointed out the weakness of domestic regulators and supervisors. Vietnam launched its transition process in 1986 and since then the financial system has experienced three decades of development and change. The temporary recession of the economy in general and the banking sector in particular during the past 5 years (2011−2015) can be attributed to poor regulation and supervision in Vietnam (Nguyen and Simioni, 2015).

Lastly, cash payments remain common in Vietnam due to consumer habits and preferences. This issue means the clients of banks do not liketo keep their money in bank deposits, rather they hold cash for their daily transactions. Banks must ensure that they have enough cash in their vaults to meet the needs of their clients on the one hand, but they can lose the chance to exploit earning deposits by providing more intermediation services on the other hand.

The empirical results derived from this research and the challenges highlighted above suggest a number of important policies are required, aimed at improving the efficiency and productivity of Vietnam's banking system. The reform measures conducted in the post-WTO entry period impacted banks both positively and negatively and are a source of concern for Vietnamese policy makers as they have the potential to constrain the

future development of the overall economy. As indicated by the empirical results in the previous chapter there are no cases in which all banks are efficient and located on the production frontier. It would be more practicable if the banks were striving for a higher level of efficiency. In this context the Vietnamese Government must redesign their policies towards motivating competition in financial markets and guaranteeing a sound banking system by developing a strict and strong regulatory and supervisory system.

Based on the empirical results presented previously, a number of policy implications are proposed and these are discussed in the following three sections. Section 7.2 presents suggestions and solutions to establish a competitive banking market. Measures to improve the quality of banks and relevant institutions are considered in Section 7.3. For a sound, safe and sustainable banking system, the legal and regulatory framework should be continuously consolidated with measures offered in Section 7.4. Section 7.5 concludes and summarises the main policy implications looking towards improving the efficiency of the Vietnamese banking system.

7.2 Establishing a competitive and fair banking market

7.2.1 Independence of the SBV

A number of studies (e.g, Kraft *et al*., 2006; Karas *et al*., 2010) have shown that one of the reasons for the superior efficiency of public banks over their private counterparts are the privileges and preferential treatment extended by the central bank (the SBV in Vietnam) and the government. The equity owned by the State in these SOCBs is managed by the SBV and this ensures their greater credibility to depositors in terms of their solvency. However, direct intervention by the SBV in the banking sector has

resulted in a heterogeneous banking environment that curbs fair competition and efficiency improvement. In this context two measures to increase the independence of the SBV are suggested. First, for the four equitised SOCBs, the government should decrease the state-owned equity by selling this to overseas investors[86], who would bring in expertise, advanced technology and more funding. At the moment at least seventy-five percent of the equity of SOCBs is held by the SBV and this ensures absolute control by the State. Selling more equity to foreign strategic investors could make SOCBs less dependent on the SBV and increase the opportunities for these investors to hold positions on the boards of directors which, in turn, would direct these banks towards a more commercially based footing.

Second, the independence of the SBV should be increased by transferring all the equity held by this entity to another state authority. This action would definitely eliminate the direct influence of the SBV on SOCBs' operations.[87] It is suggested that the Ministry of Finance (MOF) should, on behalf of the State, manage the equity transferred from the SBV. The MOF has the experience to hold the State's equity in most of the equitised SOEs.[88] By doing this the SBV could become, relatively, more of a policy maker and

[86] In Chapter 6 it was shown that foreign investors have been proven to exert a positive influence on bank performance.

[87] The Open Market Operations measure was established in 1999 according to Decision 340 of the SBV and this is an important market mechanism for controlling the banking sector and conducting monetary policy. Some may ask why the SBV utilises such market-based measures while persistently holding onto the SOCBs as a non-market measure. The explanation of this paradox goes beyond economics, being politically based. The Vietnamese communist party, known as the unique and State-holding party, sees SOEs in general and SOCBs in particular as the backbone of the economy and this will be their long-term role as mentioned in the 2013 Vietnamese Constitution. Article 51 of the Constitution states that the Vietnamese economy is a socialist-oriented market economy with multiple forms of ownership and a multi-sector economic structure; the state economic sector plays the leading role. This article requires SOEs to participate in all important sectors of the economy, of which the banking sector is one, and this argument clarifies why the SBV, representing the state, continues to control SOCBs even though it has adequate market-based tools.

[88]Transferring the state-owned equity in SOCBs from the SBV to the MOF would increase transparency and independence in the SBV's policies. When the SBV holds state-ownership in SOCBs, it has to be administratively responsible for all operations of these banks and this explains why the SBV tends to

the relationship with public banks would be more transparent and independent. However, this change of state authority should be seen as a short-term one because, as the minority proportion of equity in the equitised SOCBs owned by the private sector remains unchanged, consequently, the problem of agency is still unresolved. In the long-run the problem can only be addressed when all state-owned equity is sold on the stock exchange[89] as occurred in many of the Eastern and Central European transition economies (Poghosyan and Poghosyan, 2010; Bonin and Schnabel, 2011).[90]

It is worth noting that transition economies such as Vietnam and China are conducting a gradual transformation to market based economies (Beresford, 2008), during which the banking sector remains mostly under the control of government. The challenge for policy makers is to reconcile conflicts between: state ownership and bank efficiency; efficiency and the autonomy of the SBV; and lastly between state ownership and SBV autonomy. It could be more practical for the State to continue to hold 51% of SOCB equity, vested in the MOF rather than the SBV, and let the rest be owned by strategic investors.[91] Lessons from the Eastern and Central European transition economies during

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directly provide privileges and discriminative treatment (for instance, in terms of lending activities) for SOCBs. In the case where the MOF holds the state-owned equity in SOCBs, one may argue the MOF could collude with the SBV and this suggests the monetary authority of the government could continue to prefer SOCBs. Obviously, this scenario is possible but it would take time to organise due to the increased number of attending agencies (the MOF, the SBV and the government) and would be hampered by the requirement for clear explanations from the MOF acting in the role as the owner. When more authorities take part in the decision making process of the SBV, the policies generated by this agency would become more transparent and relatively more independent from the SOCBs' operations. It is worth noting that, under either the SBV or MOF management regime, the majority state ownership is unchanged; thus, the agent-principal problem remains in effect in the public banks.

[89]The total value of the stock exchange (USD 65 billion at end 2014) is much larger than the total market value of all SOCBs (USD 6.6 billion at end 2014) and the market will be strengthened by the involvement of overseas investors when the TPP becomes effective.

[90]Körner and Schnabel (2011) found a negative impact of state-ownership in banking on long-term economic growth in countries having low financial development and weak political institutions such as Vietnam has. However, this relationship is no longer clear or even positive in financially developed economies.

[91]The policy should balance two competing objectives: (1) ensuring control by the State over the banking sector so that state-owned equity can dominate in SOCBs (more than 50%), (2) improving efficiency and

the 1990s show that privatisation focusing on foreign strategic investors is more successful than other approaches[92] (Barisitz, 2009). Participation by foreign investors injects know-how, experience, technology, corporate governance and capital, thus boosting competitiveness, encouraging competition and enhancing creditability in the banking system. At the moment the equity proportion owned by overseas investors cannot exceed 30%. This limit is due to the Vietnamese State's desire to control the banking sector, hence ensuring its absolute sovereignty over the country's financial system in particular and the economy in general (Kovsted *et al.*, 2005; IMF, 2012).[93] Nonetheless, the government does expect the public banks to operate efficiently and, learning from the experiences of other transition countries, foreign investors are likely to play a strategically important part in the privatisation of SOCBs.

Holding more than half of the equity ensures control by the State; however, this also makes foreign investors suspicious of the relevant state authority's functions within the SOCBs and their contributions to the long-term strategy of these banks. As a result,

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competitiveness in SOCBs, hence increasing the equity owned by foreign strategic investors as much as possible but not equal to or exceeding 50% of total equity (suggesting a cap at 49%). At the moment, foreign investors are allowed to hold a maximum 30% of SOCB equity and the empirical evidence in the literature as well as in this thesis supports their participation in the banking sector. Hence, these objectives are compatible and achievable.

[92] There are other approaches to bank privatisation. Specifically, insider privatisation is an approach in which shares of state-owned banks are sold to employees of these banks (Barisitz, 2009). In addition, indirect privatisation occurred in countries such as Croatia where the state-owned banks are owned by other SOEs. Then when these SOEs were privatised, the banks were indirectly privatised (Kraft *et al*., 2006).

[93] As long as article 51 of the Vietnamese constitution is effective the government will not remove the restrictions imposed on foreign investors in the banking sector. Accordingly, the state economic sector must be the driving force of the economy in general and the banking sector as an important industry in particular, despite the fact that Vietnam has fully been a WTO member and is going to be a party to the AEC and TPP. Vietnam does not accept any regulations from these free trade agreements on absolutely and thoroughly opening its banking sector. However, it is urgent to remove such limits on operations of foreign investors. This is because the banking sector in Vietnam is in turmoil due to bad loans and weak governance and it needs a strong and new capital flow from overseas in parallel with advanced expertise and technology to strengthen itself. The two conflicting issues cannot be thoroughly addressed in the economic-political context of Vietnam these days. Nonetheless, compromising suggestions as mentioned in the previous section, such as reducing the state-ownership equity in SOCBs but ensuring the State still dominates the total and increasing the fraction of equity available to be held by foreign investors up to but not exceeding 50%, seem practicable and achievable.

regulation on the functions and limits on state representatives in the public banks needs to be issued as a guarantee for the benefit of investors and to ensure the operations of SOCBs are clear, transparent, accountable and commercially based. The experiences of other transition economies in Europe show that, to attract overseas strategic investors, institutional and legal conditions (notably protection of property rights and the rule of laws and contracts) play a pivotal function (Barisitz, 2009). Moreover, the CEOs of public banks should be chosen through a competitive and transparent recruitment process rather than being appointed by a board of directors consisting of the representatives of both private institutions and state authorities, as it has been. A contract mechanism[94] could be implemented for the CEOs of public banks in which they have to commit to achieving certain objectives imposed by the board of directors.

7.2.2 Removing barriers against foreign banks/investors

The empirical evidence from Chapter 6 reveals that the participation of foreign investors in domestic banks helps improve efficiency. However, the government has a limit of 30% on the equity of a bank, either public or domestic private, that foreign investors can buy. This limitation has prevented technology transfer and long-term co-operation with foreign investors. Hence, the 30% limit should be eliminated or at least be loosened to a significantly higher percentage of 49%.

In the Eastern and Central European transition economies during the 1990s there was no limit on the participation of overseas investors in either private or state-owned banks (Bonin and Schnabel, 2011). However, in the case of Vietnam, the limit on maximal equity participation should be completely eliminated for private banks and a limit

[94]Shleifer and Vishny (1997) state that contract mechanisms alleviate the agent-principal problem and, therefore, increase firm efficiency.

of49% of equity owned by foreign investors can be applied in SOCBs as discussed in Section 7.2.1. Further participation of foreign investors in the banking sector in Vietnam could help provide more capital inflow from overseas, and additionally could provide advanced technology and a high quality of corporate governance.

7.3 Improving relevant institutions/banks

7.3.1 Mergers and acquisitions (M&As)

In the previous chapter it was found that the JSBs that transformed from rural to urban banks are less efficient under both the intermediation and operating approaches. Moreover, the Hicks−Moorsteen index based results show that scale effects impact significantly on productivity changes of the Vietnamese banking system. Consequently, a possible solution for these small, inefficient banks is that the SBV should require them to merge or be acquired by larger and sounder domestic banks.[95] This argument is also supported by Wheelock and Wilson (2000) when they empirically show that small and managerially inefficient banks, in general, are more likely to be acquired or controlled for leverage. At the moment foreign banks are not permitted to take part in merger and acquisitionactivities; nonetheless, the experience of Eastern and Central European transition economies shows that overseas investors are the main driving force of

[95] One may argue that the merger and acquisition policy would undermine the capital structure of the acquiring/merging banks. To avoid such a problem and following the lessons learned from the EAFC (Williams and Nguyen, 2005), the SBV needs to issue a standard procedure in which the asset and equity values of acquired/merged banks have to be precisely identified beforehand. For this purpose, bad assets and loans must be removed from the balance sheet and relevant loan-loss provisioning costs must be adequately accounted for. In the aftermath, based on the market values of equity of both acquiring/merging and acquired/merged parties, the transfer rate of acquired/merged bank equity into acquiring/merging bank equity will be identified. Such measures would ensure the fairness of any merger and acquisition transactions and the quality of assets and equity of the new banks after the acquiring/merging processes. Accordingly, the value of capital ratio may change but the quality of capital and assets of the acquiring/merging banks will not be negatively impacted.

mergers and acquisitions (Hasan and Marton, 2003; Bonin *et al*., 2005a; 2005b; Fang *et al.*, 2011). Through mergers and acquisitions, transformed banks have the opportunity to widen their operating range and save operating costs (Wheelock and Wilson, 2000). Furthermore, they can be supported by their partners to innovate, improve their governance, and improve risk management and capital capability (Houston *et al*., 2001; Worthington, 2001).

7.3.2 Improving the quality of risk management in JSBs

The JSB model shows that private banks with a higher loan to asset ratio (a proxy for risk preference) are less efficient than other banks in the same group under the operating approach. This result raises a concern about the quality of risk management in private banks. Possible policy suggestions for this problem include: 1) issuing stringent regulations on lending activities, the capital adequacy ratio, credit limitations, the loan to deposit ratio, the maximum ratio of short-term liabilities over mid- and long-term loans, and liquidity ratios; 2) calling for foreign strategic investors to take part in private domestic banks. These investors can help improve the quality of risk management through banking technology transfers and training of bank staff; and 3) diversification of banking activities in order to decrease the loan to asset ratio. One of the weaknesses of domestic banks compared to their foreign rivals is that they concentrate their business on lending that, in turn, can lead to a risky asset portfolio.[96] A diversification of banking services would help banks avoid systematic risks from the market and become more resilient to external shocks.

[96] Wheelock and Wilson (2000) argue that loans are typically the least liquid and most risky bank assets and the more the banks concentrate on loans, the greater the likelihood of failure. A study by Laeven (1999) showed that in emerging markets with weak enforcement of banking regulations, banks with excessive loan growth would show a high technical efficiency by taking on excessive risk. Rapid growth of loans in the short- and mid-term is traded off against an increase of credit risk in the long-term.

7.4 Consolidating the legal and regulatory framework

7.4.1 Improving Vietnamese bank accounting standards

According to assessments by the IMF, the Vietnamese system relating to banking regulations is still far from international accounting standards and the Basel Accord I, and is not capable of catching up with recent developments in the banking sector (IMF 2012; 2014). Vietnamese Accounting Standards (VAS) were mainly established in 2003 by the Law of Accounting and they tend to overstate profitability, asset values and the solvency situation of reporting entities. In the case of SOEs, the weaknesses of the VAS are aggravated by supplemental accounting rules against "the loss of state capital" that hinder recognition of losses and mask the weak performance of several SOEs (IMF, 2014). Moreover, the empirical evidence in the previous chapter shows the weakness of temporary bank accounting standards. In particular, the negative relationship between the equity to asset ratio and operating efficiency is due to the fact that risk-related costs are inadequately accounted for.

Hence, the hidden risks inside the banking system are underestimated. Another consequence is that the relevant authority may then issue distorted or inadequate policies on banks when they are not receiving enough reliable information on banking operations under the weak and poorly enforced bank accounting and regulatory standards. It is necessary to create a new system of accounting standards for banking that can handle the evolution of banks and can account for all activities and possible risks.

7.4.2 The law on internet banking

The analysis of productivity from this study has shown that the technical component of Vietnamese banks regressed during the studied period and this has resulted in a decline of Vietnamese banking productivity. According to Lin *et al.* (2015), the percentage of Vietnamese people using the Internet in 2014 is 40% and of the total 89.6 million citizens, 24 million were ATM card holders. There are 48 card issuers, 11,000 ATMs and 38,000 EFT points of sale nationwide in 2012. Moreover, all commercial banks did have Internet-based services by the end of 2014. However, few people have used these new Internet banking products as only 1.16% of total transactions were conducted by this means in the first half of 2014[97]. The reasons for this fact are: the preference for cash payments by consumers, weak coordination among banks, worries about security and privacy, and an inadequate perception of usefulness (Lin *et al*., 2015).

The consequence of the lack of popularity of Internet banking activities is that banks still have to maintain a large number of employees and branches and this results in a high operating cost. By using internet banking, clients could perform banking transactions at home or at their work and the banks could serve a much larger client base with a smaller number of staff and branches. The application of internet banking helps banks to save costs and improve productivity (Wheelock and Wilson, 1999; Berger, 2003). In order to encourage people to use internet banking services and ensure that all relevant transactions are guaranteed, the Vietnamese Parliament should issue a law on internet banking to establish a legal background for this type of service.

[97]Source: *http://www.sbv.gov.vn/portal/faces/vi/pages/trangchu/hdk/cntt/udptcntt/udptcntt_chitiet?dDocName=SBVWEBAPP01SBV075439&dID=77608&_afrLoop=3366875192051715&_afrWindowMode=0&_afrWindowId=null#%40%3FdID%3D77608%26_afrWindowId%3Dnull%26_afrLoop%3D3366875192051715%26dDocName%3DSBVWEBAPP01SBV075439%26_afrWindowMode%3D0%26_adf.ctrl-state%3Deyauo4b0w_4*

7.4.3 The law on cross-ownership

As discussed previously, cross-ownership has been occurring between business groups and private banks. This includes ownership of JSBs by other banks (SOCBs and other JSBs) and by business groups (including SOEs), and this complicated shareholding structure raises concerns about conflicts of interest, connected lending and distorted credit allocation. The results from Chapter 6 show that this nexus has negatively impacted bank performance in terms of profit maximisation and the provision of intermediation services.

The circumstance of the Vietnamese banking sector in the post-WTO period is somewhat similar to that of countries (including Indonesia, Korea, Malaysia, the Philippines and Thailand) during the East Asia Financial Crisis. According to Williams and Nguyen (2005) these economies are characterised by the prevailing dominance of large, and in some cases family owned, corporations which owned financial subsidiaries, circumventing restrictions on lending. This interrelated economic model between finance and ownership lay behind connected lending and was a major root cause of the EAFC. This potential problem was compounded by an underdeveloped institutional environment characterised by weak supervision and regulations. In general, governments in these aforementioned Asian countries responded to the financial distress by: nationalising banks; closing unviable banks; carrying out compulsory purchases and transferring assets to healthy and sound banks; creating larger core banks; removing bad assets to state-owned and managed asset management companies; and injecting capital to recapitalise banks (Laeven, 1999; Williams and Nguyen, 2005). When these measures were completed these restructured and nationalised banks were returned to the private sector through a privatisation process (Lindgren *et al*., 2000; Radelet and Sachs,

2000). Other solutions were also implemented to improve the quality of management and ensure that these restructured banks would be more transparent, efficient and safer including: broadening access for foreign-owned banks and allowing majority foreign ownership; replacing underdeveloped management; and revising managerial incentives. Furthermore, international standards on supervision and regulation were implemented in order to improve the institutional environment.

Vietnam can learn from the experiences of these Asian countries to resolve its similar problems. For example, nationalising or even closing unviable banks; establishing an asset management corporation[98]; allowing majority foreign ownership[99]; and applying international standards to establish a sound regulatory and supervisory framework including enacting a law on cross-ownership.

7.4.4 The law on bank regulation and supervision

To maintain a sound and efficient banking sector Vietnam has to improve its banking regulatory and supervisory framework as it currently is underdeveloped and faces substantial challenges (IMF, 2012; 2014). A law on supervision should be enacted to address serious gaps in the regulatory framework. These gaps include:

(1) the definition of related parties[100] is overly narrow, hindering the identification and assessment of ultimate beneficiaries. This affects various

[98] The Vietnam Asset Management Company was indeed established in 2013.

[99] Foreign investors should be allowed to hold more than half of the capital of domestic banks. By doing this they will commit to long-run investments and, by taking control of the domestic banks, the quality of management will be improved to meet international and far more advanced standards.

[100] According to International Accounting Standard 24, a related party is a person or entity that is related to the entity that is preparing its financial statements. At the moment the definition of related parties in the banking sector in Vietnam is narrow and it has not caught up with the international criterion and has not adequately accounted for all people and corporations possibly impacting on the operations of banks (IMF, 2014). As a result, risks relevant to related parties may be ignored.

aspects of supervision, including licensing, transfer of ownership, acquisition, related party lending and capital adequacy (IMF, 2012; 2014);

(2) the framework of authorisation is too prescriptive and does not allow enough room for supervisors to conduct proper screening and assessment; and

(3) capital adequacy requirements are still based on the Basel I Accord and there is a lack of guidance on market, operational and interest rate risks (IMF, 2012; 2014).

7.5 Summary

In this chapter, valuable policy implications and recommendations have been drawn from the empirical evidence presented in this thesis that include:

(1) the impact of policy changes in the post-WTO era and of bank specific variables on the technical efficiency of the Vietnamese banking sector during the 2005−2012 period using a double-bootstrap two-stage DEA model and meta-frontier analysis;

(2) comparisons of technical efficiency between public, private, foreign and joint venture bank groups using the Li (1996) and the Simar and Zelenyuk (2007) tests; and

(3) analysis of Vietnamese bank productivity using the AMPI.

In order to improve the technical efficiency and productivity of Vietnamese banks, specific policies should be targeted on:

(1) ensuring the independence of the SBV by reducing the volume of equity owned by the State in SOCBs and transferring the equity to the MOF;

(2) removing all limits relevant to the participation of foreign investors in domestic banks;

(3) requiring small and inefficient banks to merge/be acquired by bigger, financially sound banks;

(4) improving the quality of risk management in private banks by issuing stringent regulations on lending, thereby encouraging foreign investors to take a larger part in management and diversification of banking activities;

(5) improving Vietnamese bank accounting standards to adequately account for recent developments in the banking sector;

(6) enacting a law on internet banking to ensure the benefits are taken up and to enhance its credibility for consumers;

(7) enacting a law regulating cross-ownership in private banks to ensure that there are no conflicts of interest or connected lending and to avoid distorted credit allocation; and

(8) consolidating the regulatory and supervisory framework by enacting a law on bank regulation and supervision.

In the next and final chapter, the major conclusions from the thesis, limitations and suggestion for further research will be presented.

Table 7.1: A summary of the key challenges and implications for policy makers relating to the Vietnamese banking sector

Findings	Challenges and limitations	Implications for policy makers
Treatment of the SBV: extending privileges to SOCBs and discriminating against JSBs and FJVBs. As a result, SOCBs access the production frontier more easily than other banks.	Independence of the SBV	1) The government should broaden the equity ownership of SOCBs to include private and foreign investors (it is suggested that the maximal proportion of equity owned by the private sector be set at 49%). 2) The equity in SOCBs held by the SBV should be transferred to another state authority (the MOF is suggested). In the long-run, under a planned roadmap, this state-held equity should be returned to the private sector through selling on the stock exchange and sales to strategic foreign investors.
JSBs with foreign investors are more efficient than the other bank types under the operating approach. FJVBs are more efficient than JSBs under both approaches.	Barriers against foreign banks/investors	1) Remove the 30% ceiling on bank equity that can be sold to foreign investors. 2) Remove the restrictions on financial services imposed on foreign banks. 3) Allow foreign banks to establish branches and offices nationwide.
The rural-urban transformed JSBs are the least efficient under both approaches.	Rural-urban transformed banks	1) Nationalise these banks and after that, sell to potential investors including foreign investors. 2) Force them to be acquired/merged with bigger, financially sound banks.

Findings	Challenges and limitations	Implications for policy makers
JSBs with a higher loan to asset ratio are less efficient under the operating approach.	Poor quality of risk management in private banks	1) Issue stringent regulations on banking activities. 2) Encourage foreign investors to take part in private banks. 3) Diversify banking activities.
The cross-ownership between JSBs and business groups negatively impacts bank performance in terms of profit maximisation and the provision of intermediation services.	Cross-ownership	1) Nationalise or close unviable cross-owned banks. 2) Carry out compulsory purchases and transfer assets to healthy, financially sound banks. 3) Broaden access for foreign-owned banks to take part in restructuring processes by acquiring weak banks or becoming majority shareholders.
Negative relationship between the equity to asset ratio and operating efficiency exposes the fact that risk-related costs are inadequately accounted for.	Weak accounting standards on banking	1) Review and rebuild the domestic accounting standards to catch up with international standards.
Based on all the above findings. Banking productivity has declined due to technical regression.	Gaps in banking legislation	1) Build three banking-relevant laws: - Law governing internet banking - Law on cross-ownership - Law on bank regulation and supervision

Chapter 8: Summary and conclusions

8.1 Introduction

There is a close and positive relationship between economic growth and a country's level of financial development in both developed and newly emerging market economies (Levine, 1997; 1998; Beck *et al.*, 2000). In Vietnam, the banking sector contributes a substantial proportion, 90%, of the total assets of the financial system (IMF, 2014), and thus plays a pivotal role in providing capital to the economy. As a consequence, the efficiency and productivity of the Vietnamese banking sector impacts significantly on the quality and magnitude of economic growth.

Vietnam's entry to the WTO in 2007 marked an important point in the banking sector's liberalisation; accordingly, a number of policy measures were conducted to improve bank performance and competitiveness. For example, as part of its commitments to the WTO, overseas investors were allowed to open 100% foreign-invested banks in Vietnam. These banks are recognised as being important because of their advanced technology and high quality of governance. Foreign investors, furthermore, are allowed to take part in domestic banks as minority shareholders. Rural banks are permitted to transform into urban banks. Four of the five state-owned banks were equitised and foreign strategic investors were encouraged to participate in this process. The pre- and post-WTO entry period experienced rapid credit growth at an average rate of 35% annually[101]. The relevant policy changes after the WTO event could be expected to have impacts on bank efficiency and productivity; however, no study has been carried out to assess these possible impacts. Therefore, the aim of this thesis has been to shed light on

[101]See Chapter 2 for more details.

the impact of WTO entry on bank efficiency and productivity in Vietnam, which is seen as being critical to the future sustained growth of the economy.

The objective of this study has been to answer the following questions: 1) How has the Vietnamese banking sector evolved since its transformation from a one-tier to two-tier system in 1988? 2) Which methods can be best utilised to measure and analyse the efficiency and productivity of a banking sector, especially in the case of a transition economy such as Vietnam's? 3) What has been the level of efficiency and productivity changes in Vietnamese banks encompassing the pre- and post-WTO entry periods? 4) What has been the impact of policy changes implemented after WTO accession? 5) What are the important sources of inefficiency from the perspective of the Vietnamese banking system?

This chapter summarises the main findings related to these questions and is structured as follows. Section 8.2 provides a summary of the main findings presented in previous chapters and how these findings address the research questions and hypotheses highlighted in Chapter 1. The policy implications and recommendations for the SBV and Vietnamese government to improve banking sector performance provide the focus of Section 8.3. Section 8.4 offers a description of the study's limitations. Lastly, Section 8.5 suggests areas for further research based on the limitations and possible extensions of the thesis.

8.2 Summary of empirical findings

8.2.1 Findings for the research questions

As the focus of the thesis, a number of research questions and hypotheses were raised in chapter 1. The questions and hypotheses concentrated on: estimating and comparing the technical efficiency and productivity performance of the Vietnamese banking system during the 2005−2012 period, examining the significance of policy changes implemented in the post-WTO accession period, identifying bank-specific characteristics and time trends impacting on bank performance, and identifying key policy priorities for the government and the SBV concerned with enhancing the technical efficiency and fostering the productivity of the Vietnamese banking sector. The main findings for each of these research questions are now discussed.

How has the Vietnamese banking sector evolved during its transformation from a one-tier to two-tier system starting in 1988?

To answer this question, the literature related to the historical development of Vietnam's banks from initiation of the transformation process from a mono system to a two-tier system in 1988 to the present was collected, reviewed and analysed. During this time period both the successes and failures relating to the Vietnamese banking sector were analysed in depth; moreover, a comparison with other transition countries was also conducted highlighting differences and similarities. In general, evolution of the Vietnamese banking sector can be divided into four phases: (1) the first phase (1988−1997) marked the transition process from a one- to two-tier banking system which ended with the onset of the EAFC, (2) the second phase (1998−2006) is characterised by a substantial change in the legal system with the issuance of the

banking law that formulated the functions of the SBV and eliminated direct control over the interest rate, (3) the third phase (2007−2010) recorded a dramatic growth of the banking sector after Vietnam joined the WTO in 2007; however, turmoil arising from hidden risks related to financial asset bubbles and intra-lending activities generated concern for policy makers, (4) the fourth phase began from 2011 up to the present and was characterised by reform measures to stabilise and sustainably restructure the banking system. Overall, development of the Vietnamese banking sector has been significantly impacted by economic liberalisation and integration such as from its membership of the WTO in 2007 and from its membership of regional free trade agreements such as the AEC and TPP in 2015.

What methods can be utilised to measure and analyse the efficiency and productivity of a banking sector, especially in the case of a transition economy such as Vietnam's?

The non-parametric method – DEA was employed to estimate the production frontiers and measure the efficiency and productivity of Vietnamese banks and the overall banking sector during the period 2005–2012. An advantage of this thesis is that the author employs bootstrap techniques in the context of DEA which can give less biased and more consistent estimates of efficiency; therefore, the results obtained are more reliable. The bootstrap-based tests of Simar and Zelenyuk (2006) and Simar and Zelenyuk (2007) have been utilised to examine bank technical efficiency differences across different periods and amongst groups. Furthermore, applying the double-bootstrap two-stage DEA method of Simar and Wilson (2007) to examine the impact of environmental variables on efficiency is another merit of this study because the method provides less biased and more consistent coefficients. An aggregate Malmquist productivity index was initially utilised to measure bank performance. The advantage of

this method is that it accounts for the relevant importance of individual banks (weighting) while conventional Malmquist productivity indexes see banks as having equal weighting. Furthermore, Hick−Moorsteen index that is knows as a multiplicatively complete TFP index was also utilisd in this thesis. This better index provides a comprehensive measures of efficiency changes in a comparison with any types of Malmquist index. By combining the double-bootstrap two-stage DEA with a meta-frontier analysis, this approach was proven to be the appropriate methodology for analysing the Vietnamese banking sector where the business environment in which banks are operating is heterogeneous. Therefore, the author has addressed the question of which methodology should be employed to analyse the performance of Vietnamese banks.

What has been the level of efficiency and productivity changes in Vietnam's banks encompassing the pre- and post-WTO entry periods?

In answering this question, DEA-based tests including those of Li (1996) and Simar and Zelenyuk (2007) were utilised to measure and compare the technical efficiency of Vietnamese banks between the pre- and post-WTO periods. The analysis was carried out using unbalanced panel data obtained from the financial reports of commercial banks in Vietnam consisting of state-owned, domestic and foreign private banks from 2005 to 2012. A total of 232 bank-year observations were used to measure technical efficiency, as presented in Section 5.2 of Chapter 5. The empirical results indicated that the banking sector in both the pre- and post-WTO periods operated below its potential capability using both aggregate and mean technical efficiency, and the values of efficiency estimated by the intermediation approach were bigger than those estimated under the operating approach.

The Simar and Zelenyuk (2007) test shows that the technical efficiency of the Vietnamese banking sector in the pre-WTO period is the same as that in the post-WTO period, using both the aggregate and mean criteria and under both the operating and intermediation approaches. The equality of efficiency between the two periods implies that there was no significant improvement in bank performance. The policy measures implemented in the wake of WTO entry aimed at improving the technical efficiency of banks, therefore, proved to be largely ineffective. This conclusion is also supported by the Li (1996) test on the distribution of efficiency scores between the two periods. The results of the Li (1996) test show that the capability of banks to access the industry frontier in the pre-WTO period is the same as that in the post-WTO period under both approaches to input/output data.

What has been the impact of policy changes implemented after WTO accession?

For each policy change a hypothesis was elaborated to postulate its possible impact on bank performance, as indicated in Chapter 1. In order to identify these impacts, dummy variables were used as proxies for relevant policy changes and were utilised in the different models. Under the meta-frontier analysis approach, banks belonging to different ownership types are assumed to have their own technology sets and this required estimating the production frontier for each group. There are two types of models that can be used: (1) a meta-model that embraces all banks regardless of their ownership, (2) a group model that only includes banks of a specific ownership type, and there are three group models that are relevant - state, private and foreign ownership. For each model a regression is conducted to observe the impact of a specific policy change on bank efficiency and repeated twice under the two approaches to input/output data.

The impacts of policy changes in the post-WTO era were hypothesised and they are presented in detail in section 8.2.2;

What are the important sources of inefficiency in the Vietnamese banking system?

The empirical analysis in this study showed two sources of inefficiency in the Vietnamese banking sector. First, policy changes in the post-WTO period when Vietnam had to conduct its commitments after joining this organisation. Details on the possible impact of these banking-related policy changes are presented in section 8.2.2 below. Second, other control variables including bank characteristics and a time trend capturing the evolution of bank efficiency along a timeline starting in 2005 (before the WTO entry event - 2007) and ending in 2012 are also included in the regression models to see their influence.

To see the impact of asset structure on bank efficiency the loan to asset ratio (LA) was employed across the meta- and all three group models (JSB, SOCB, and FJVB models). Under the intermediation approach the results are consistent and show a significant and positive relationship between the LA ratio and bank efficiency. Nevertheless, the results are inconsistent under the operating approach. In the JSB model the above mentioned relationship is negative while it is positive in the two remaining group models (SOCB and FJVB models).

The equity to asset ratio (EA) represents capital strength and its relationship with bank efficiency. Using the profit maximising criterion to input/output data, the relevant coefficients of all meta- and three group models show a consistent result that the EA ratio has a negative relationship with bank performance. However, results using the intermediation approach are inconsistent. A negative association between capital

strength and bank efficiency is recorded in the JSB and SOCB models but it is positive in the FJVB model.

The characteristic of bank profitability is proxied by the return on asset ratio (ROA) and this variable appears in all four regression models. The relationship of ROA with that of bank efficiency is consistently positive across the different models under the operating approach. Meanwhile, the impact is inconsistent across different group models under the intermediation approach to input/output data. Specifically, bank profitability has a negative impact in the FJVB model while it is positive in the other two group models including those for private and public banks.

To control for the impact of a time trend on bank performance, the variable T is used and constructed linearly under the rule that for the first year it receives a value of one and receives a value of two in the second year. This process is repeated until the last year of the studied period. The empirical results showed that the time trend is significant in the meta- and JSB model using the operating approach; meanwhile, under the intermediation approach the variable is significant in the meta-, JSB, and SOCB models. The disparity of bank groups' reaction to the time variable implies that banks belonging to different ownership types evolve along a variety of directions, and this is also significant evidence to support the assumption that the business environment in Vietnam is heterogeneous and, operating under such conditions, bank groups cannot have the same trajectory of development.

8.2.2 Findings for the research hypotheses

To know whether the impact of a policy change is significant or not, the values of the relevant coefficients of the dummy variables were compared to zero. The double-

bootstrap two-stage DEA method provided a sampling distribution of each coefficient and also identified its confidence interval that is characterised by upper and lower values. At α significance degree, if both bounds are smaller than zero then it can be concluded that the related coefficient value is significantly negative. On the other hand if both bounds are bigger than zero then the conclusion is that the coefficient value is significantly positive. The rest of this section focuses on how the empirical results answer the hypotheses posed in chapter 1.

Hypothesis 1:

The capital participation of several large SOEs and private business groups decreased the efficiency performance s of banks.

The dummy variable BG appearing in the meta- and JSB model was used as a proxy to indicate the capital participation of private and state-owned business groups in JSBs. There is evidence to suggest that the efficiency of private banks with cross-ownership from business groups deteriorated under the profit maximising criterion. Specifically, the coefficients of BG were significantly positive under the meta- and group models. This empirical proof supports hypothesis 1 that cross-ownership has resulted in a misallocation of credit that has eventually resulted in bad loans. The resolution of bad loans takes time, incurs high cost and undermines the efficiency of these banks.

Hypothesis 2:

Privatisation of SOCBs has increased the technical efficiency of these banks.

Privatising public banks is a measure to alleviate the agency problem and increase bank efficiency as postulated in hypothesis 2. The influence of this policy change was

presented by the dummy variable P, referring to privatised SOCBs. This binary variable appears in both the meta- and SOCB models. Under the operating approach the empirical results showed a significant and positive impact of P in the two mentioned models and also provided support for hypothesis 2. Under the intermediation approach the impact of P was positive in the meta-model but was negative in the SOCB model, implying that privatised banks are less efficient than non-privatised banks. This result can be explained by the fact that, after privatisation, SOCBs became more cautious in their lending activities and more commercially-based when their priority is profit rather than providing credit as much as possible to targeted economic sectors or areas.

Hypothesis 3:

Foreign involvement in domestic banks (both SOCBs and JSBs) has exerted a positive impact on the technical efficiency of Vietnamese banks.

To test hypothesis 3 the dummy variable FSI was included in the regression models and indicates banks with foreign involvement. The variable FSI appears in both the meta-model and group model. Due to the fact that when SOCBs are privatised their equity is simultaneously sold to strategic investors; we cannot distinguish between the two variables FSI and P in the SOCB group model. In addition, allowing overseas investments in SOCBs is just an important component of the privatisation process and so FSI is excluded from the SOCB model. Consequently, FSI was included in only the meta-model and JSB model.

In the JSB model the empirical outcome showed a positive impact of foreign participation in private banks on income-based efficiency, and this outcome supports hypothesis 3 that strategic investors from overseas with expertise, advanced technology

and strong capital capability can contribute positively to the decision making process of domestic banks, improve the quality of management, and develop new banking services and products.

Hypothesis 4:

The deregulation of rural banks into urban banks by the SBV reduced the mean efficiency of the banking sector.

To examine the impact of transforming rural into urban banks by the SBV the dummy variable RU was utilised to distinguish transformed banks from others. The RU variable was included in the meta- and JSB models. The regression outcomes demonstrated a negative relationship between RU and bank performance under the two approaches and two mentioned regression models. Accordingly, the results support hypothesis 4 that, under an inadequately selective process, the decision of the SBV to transform rural banks into urban ones resulted in their low efficiency in particular and deteriorated the performance of the banking industry in general.

8.3 Policy implications and recommendations

The empirical analysis presented in this thesis has shown that Vietnamese banks are operating far from their optimal capability, especially in terms of providing intermediation services, and it is likely to constrain the development of the financial system and economic growth. A number of policy implications and recommendations have been suggested to improve the efficiency and productivity of the banking sector.

First, the authorities need to establish a competitive and fair market for all banks regardless of which type of ownership they belong to. This could be achieved via

reducing or divesting equity in SOCBs held by the SBV, and eliminating or increasing the maximal proportion of equity that can be owned by foreign investors in Vietnamese banks.

Second, the SBV has to implement measures to upgrade the quality of banks. Due to the scale effect, the weak and small banks, especially rural-urban transformed banks, should be encouraged to merge or be acquired by sound big banks. The quality of risk management can be improved by issuing stringent regulations on lending, capital adequacy ratio, credit limitation, loan to deposit ratio; calling for foreign strategic investors to participate in private banks; and diversifying banking operations. Banks should be regularly recapitalised and this can be seen as a guarantee against equity-loss risks.

Third, the legal and regulatory framework needs to be consolidated in order to increase the transparency and accountability of banks. There are a number of laws on banking activities suggested for efficiency improvement that need to be constructed, including a law on the accounting standards of banking, a law on internet banking, a law on cross-ownership, and a law on banking regulation and supervision.

8.4 Limitations

There are a number of limitations of this thesis. First, due to the long-term process involved in completing this study, new and advanced techniques relating to DEA have not been incorporated. The double-bootstrap two-stage DEA of Simar and Wilson (2007) is based on the strict condition that the production set and environmental variables are separable. This weakness can be overcome by using conditional efficiency

measures as suggested by Bădin *et al*. (2012; 2014) and Daraio and Simar (2014). Another limitation is that the aggregate Malmquist productivity index is a DEA-based method and so it inherits the downward-biased nature of DEA efficiency estimates and cannot allow for statistical inference. The quality of accounting data is also a limitation due to out-dated Vietnamese accounting standards if compared with present international accounting standards. In term of methods to estimate production frontiers, the parametric methods such as SFA can be applied in this thesis and it has a number of advantages when compared with DEA, for example, SFA allows for random errors. Using dummies to examine hypotheses can limit other alternatives to test these hypotheses in more controlled environment. Lastly, although the author has tried to collect data on bad loans it has not been possible to obtain this from the SBV. Once the data for bad loans becomes available the performance of Vietnamese banks can be analysed using this undesirable output/outcome.

8.5 Areas for further research

The limitations and empirical evidence presented in this thesis propose further academic work in order to enrich our understanding and knowledge of the banking sector in general and Vietnamese bank efficiency in particular. An opportunity for future research is to develop an algorithm to incorporate the bootstrap technique into an aggregate Malmquist productivity index.

Second, when the data on bad loans become available then this variable can be seen as an undesirable output because banks have to account for these loans as a provisioning cost and consequently reduce their profitability. The bad loans and other desirable outputs such as loans and investments are simultaneously generated from the production

process of banks. Thus, the efficiency of Vietnamese banks can be measured more comprehensively and consistently if incorporating bad loans.

Third, in terms of technical issues, it would be more consistent for empirical analysis of the impact of environmental variables on bank efficiency if conditional efficiency measures were utilised. This new method does not require a separability condition on the relationship between input-output combinations and environmental variables as is the case for double-bootstrap two-stage DEA.

The second and the third areas for further study can be combined to give a comprehensive measure of bank efficiency at the first stage and consistent results on the impact of variables at the second stage.

This study has also highlighted the similarity of China and Vietnam's conduct of a gradual approach to the liberalisation of the banking sector. A comparative study of the impact of reform measures implemented after the WTO event on bank performance in these two banking systems would be an interesting area for future research.

Appendix A: Technical efficiency between pre- and post-GFC period

Table A1: A comparison of technical efficiency between pre- and post-GFC period using Simar and Zelenyuk (2007) test

	Intermediation Approach							Operating Approach						
	DEA Estimation	Standard Error	Bias Correction Estimation	Confidence Interval Bounds				DEA Estimation	Standard Error	Bias Correction Estimation	Confidence Interval Bounds			
				90%		95%					90%		95%	
Agg.Eff. Pre-GFC	1.1144	0.0348	1.1676	1.1031	1.2105	1.0866	1.2149	1.1191	0.0332	1.1775	1.1132	1.2173	1.0944	1.2211
Agg.Eff. Post-GFC	1.1420	0.0273	1.2147	1.1623	1.2515	1.1502	1.2554	1.1137	0.0232	1.1713	1.1279	1.2020	1.1165	1.2054
Agg.Eff.	1.1352	0.0210	1.2060	1.1668	1.2356	1.1552	1.2392	1.1149	0.0194	1.1747	1.1390	1.2015	1.1296	1.2051
M.Eff. Pre-GFC	1.2717	0.0591	1.3959	1.2835	1.4783	1.2577	1.4873	1.2957	0.0523	1.4413	1.3452	1.5189	1.3282	1.5282
M.Eff. Post-GFC	1.3158	0.0419	1.4818	1.4055	1.5458	1.3883	1.5538	1.2809	0.0414	1.4150	1.3412	1.4754	1.3224	1.4835
M.Eff.	1.3038	0.0376	1.4586	1.3916	1.5148	1.3760	1.5224	1.2850	0.0393	1.4219	1.3536	1.4813	1.3364	1.4890
AER	0.9758	0.0403	0.9586	0.8892	1.0189	0.8698	1.0294	1.0049	0.0357	1.0049	0.9419	1.0566	0.9251	1.0654
MER	0.9631	0.0558	0.9274	0.8274	1.0137	0.8071	1.0268	1.0090	0.0415	1.0147	0.9446	1.0792	0.9242	1.0921

Notes: Agg.Eff. Pre-GFC and Agg.Eff. Post-GFCare aggregate efficiency scores of banks in the pre- and post-GFC era, respectively. Agg.Eff is the aggregate efficiency score of the whole sample covering both the pre- and post-GFC era. M.Eff. Pre-GFC and M.Eff. Post-GFCare mean efficiency scores of banks in the pre- and post-GFC era, respectively. M.Eff is the mean efficiency scores for the whole sample. AER is the ratio of the aggregate efficiency score of banks pre-GFC on that of the post-GFC period. MER is the ratio of the mean efficiency score of banks pre-GFC to that post-GFC. For each significance degree, there are two columns indicating the upper and lower bounds of the estimators. The AER and MRE both include unity at the 10 and 5% of significance degrees, under the intermediation and operating approaches, implying an equality of efficiency scores between pre- and post-GFC periods.

Table A2: Li (1996) test on the technical efficiency density of banks in the pre- versus post-GFC era

	Ho (f is density)	Li test [p_value]	Decision on Ho
Intermediation approach	f1(pre-GFC) = f1(post-GFC)	0.6856 [0.3750]	Cannot reject Ho
Operating approach	f2(pre-GFC) = f2(post-GFC)	-1.0546[0.1317]	Cannot reject Ho

Note: Ho: densities of the two bank groups are equal. The p-values at 0.3750 and 0.1317 under the intermediation and operating approaches suggest an equality of efficiency density functions between pre- and post-GFC periods.

Appendix B: Confidence interval of coefficients in meta- and group models

Table B1: Confidence interval of coefficients estimated in meta model

	Operating approach						Intermediation approach					
	99%		95%		90%		99%		95%		90%	
Intercept	0.9737	1.5576	1.0377	1.4826	1.0747	1.4380	1.9320	2.7385	2.0674	2.6660	2.1176	2.6215
BG	-0.0327	0.2089	-0.0015	0.1815	0.0124	0.1694	-0.1700	0.1625	-0.1196	0.1303	-0.0990	0.1104
P	-1.0855	-0.1983	-1.0108	-0.3945	-0.9774	-0.4727	-1.5772	-0.1333	-1.4859	-0.4191	-1.4377	-0.5432
FSI	-0.2108	0.0833	-0.1743	0.0470	-0.1549	0.0285	-0.2088	0.1867	-0.1630	0.1258	-0.1348	0.1020
RU	-0.0033	0.2663	0.0271	0.2295	0.0441	0.2135	0.0741	0.4422	0.1198	0.4034	0.1440	0.3790
LA	0.0996	0.8469	0.2129	0.7624	0.2535	0.7244	-2.3311	-1.1302	-2.2127	-1.2843	-2.1620	-1.3680
EA	0.8928	2.2142	1.0178	2.0329	1.0979	1.9472	-0.9446	0.8306	-0.7771	0.5843	-0.6619	0.4843
ROA	-16.1187	-4.0046	-14.8919	-5.5525	-14.1964	-6.4167	-11.1657	5.6674	-8.8371	4.0448	-7.6826	2.9600
T	-0.0803	-0.0201	-0.0735	-0.0288	-0.0692	-0.0330	-0.0635	0.0181	-0.0552	0.0046	-0.0513	-0.0003

Note: At each significance degree there are two columns indicating upper and lower bounds of the estimators. “BG” is a dummy variable that indicates JSBs with equity participation from business groups. “P” is a dummy variable that indicates SOCBs after privatisation. “FSI” is a dummy variable that indicates domestic banks with foreign strategic investors. “RU” is a dummy variable that indicates rural-urban transformed JSBs. “LA” is the loan to asset ratio. “EA” is the equity to asset ratio. “ROA” is the return to assets ratio. “T” is a time trend variable.

Table B2: Confidence interval of coefficients estimated in JSB model

	Operating approach						Intermediation approach					
	99%		95%		90%		99%		95%		90%	
Intercept	0.9530	1.3041	0.9922	1.2654	1.0125	1.2391	2.2357	3.4469	2.5002	3.3429	2.5801	3.2793
BG	0.0262	0.1852	0.0459	0.1619	0.0564	0.1518	-0.1462	0.2696	-0.0917	0.2139	-0.0633	0.1875
FSI	-0.1817	0.0020	-0.1608	-0.0202	-0.1473	-0.0309	-0.3121	0.1467	-0.2585	0.0817	-0.2316	0.0524
RU	0.0174	0.1962	0.0383	0.1699	0.0473	0.1596	-0.0008	0.4767	0.0757	0.4190	0.1049	0.3933
LA	0.2297	0.7517	0.3130	0.7099	0.3455	0.6769	-3.7768	-1.5341	-3.6186	-2.0286	-3.5025	-2.2034
EA	0.3206	1.4179	0.4615	1.3009	0.5283	1.2381	-0.6005	2.1909	-0.2791	1.8877	-0.1309	1.7138
ROA	-12.8540	-3.9785	-11.9684	-5.1568	-11.2877	-5.6650	-21.7449	1.6770	-18.9898	-1.6951	-17.9151	-3.3998
T	-0.0574	-0.0199	-0.0535	-0.0248	-0.0517	-0.0273	-0.1504	-0.0344	-0.1373	-0.0517	-0.1318	-0.0601

Note: At each significance degree there are two columns indicating upper and lower bounds of the estimators. “BG” is a dummy variable that indicates JSBs with equity participation from business groups. “FSI” is a dummy variable that indicates domestic banks with foreign strategic investors. “RU” is a dummy variable that indicates rural-urban transformed JSBs. “LA” is the loan to asset ratio. “EA” is the equity to asset ratio. “ROA” is the return to assets ratio. “T” is a time trend variable.

Table B3: Confidence interval of coefficients estimated in SOCB model

	Operating approach						Intermediation approach					
	99%		95%		90%		99%		95%		90%	
Intercept	1.0185	1.5747	1.1019	1.5124	1.1324	1.4760	1.4008	3.0754	1.5923	2.8413	1.7134	2.7130
P	-0.3066	0.0627	-0.2744	-0.0076	-0.2557	-0.0427	0.3647	1.3605	0.4732	1.2724	0.5234	1.1995
LA	-0.7846	-0.0243	-0.6859	-0.1246	-0.6426	-0.1747	-2.2723	-0.0715	-2.0677	-0.4633	-1.8960	-0.6316
EA	0.9833	7.9976	1.9812	7.3113	2.5540	6.9435	-0.1508	17.3493	2.6659	15.7974	4.2589	14.8233
ROA	-27.0337	-3.7401	-24.8441	-7.3402	-23.8153	-9.3332	-132.8996	-46.1892	-125.3304	-54.2683	-118.1186	-57.8058
T	-0.0317	0.0121	-0.0272	0.0068	-0.0249	0.0043	-0.2404	-0.0657	-0.2237	-0.0896	-0.2107	-0.0983

Note: At each significance degree there are two columns indicating upper and lower bounds of the estimators. “P” is a dummy variable that indicates SOCBs after privatisation. “LA” is the loan to asset ratio. “EA” is the equity to asset ratio. “ROA” is the return to assets ratio. “T” is a time trend variable.

Table B4: Confidence interval of coefficients estimated in FJVB model

	Operating approach						Intermediation approach					
	99%		95%		90%		99%		95%		90%	
Intercept	1.4667	3.3294	1.7509	3.1504	1.8769	3.0452	0.1784	2.9053	0.4729	2.3163	0.5931	2.0418
LA	-1.8382	0.2254	-1.5904	-0.0553	-1.4823	-0.2075	-2.2477	1.1186	-1.6624	0.5455	-1.4583	0.2947
EA	-0.3753	2.2231	0.1018	1.9135	0.2330	1.7803	-3.1478	0.4785	-2.9176	-0.3338	-2.7798	-0.7247
ROA	-50.3338	-14.3535	-48.0518	-20.1837	-46.6832	-22.7481	-9.3972	25.1850	-1.5922	21.1693	1.2834	19.9860
T	-0.1137	0.0381	-0.1000	0.0141	-0.0924	0.0030	-0.0854	0.1489	-0.0185	0.1260	-0.0025	0.1164

Note: At each significance degree there are two columns indicating upper and lower bounds of the estimators. “LA” is the loan to asset ratio. “EA” is the equity to asset ratio. “ROA” is the return to assets ratio. “T” is a time trend variable.

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